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REDACTED VERSION

**Remedial Investigation Study
for the
Remedial Investigation/Feasibility Study
at the
PAB Oil and Chemical Services, Inc.
Superfund Site
Vermilion Parish, Louisiana**

**Volume 1
Text**

**EPA Contract No. 68-W9-0032
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ACRONYMS AND ABBREVIATIONS

The following is a list of acronyms and abbreviations used in this document. Acronyms used in tables only are defined in the respective tables.

AOC	Administrative Order on Consent
ARCS	Alternative Remedial Contracting Strategy
ASTM	American Society for Testing and Materials
BRA	Baseline Risk Assessment
BTEX	Benzene, Toluene, Ethyl Benzene and Xylenes
CEC	Cation Exchange Capacity
CLP	Contract Lab Program
CFR	Code of Federal Regulations
COD	Chemical Oxygen Demand
CRDLs	Contract Required Detection Limits
EPA	U.S. Environmental Protection Agency
ESI	Expanded Site Inspection
FIT	Field Investigation Team
ft	Feet
gpm	Gallons Per Minute
HDPE	High Density Polyethylene
HI	Hazard Index
ID	Inside Diameter
K	Hydraulic Conductivity
LDEQ	Louisiana Department of Environmental Quality
LDNR	Louisiana Department of Natural Resources
LL	Liquid Limit
LNAPLs	Light, Non-Aqueous Phase Liquids
MCL	Maximum Contaminant Level
meq	Milliequivalents
MSL	Mean Sea Level
NCDC	National Climatic Data Center
NPL	National Priority List
PAB Oil	PAB Oil and Chemical Services, Inc.
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
pH	Negative Logarithm of the Hydrogen Ion Concentration
PI	Plasticity Index
PL	Plastic Limit

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PRP	Potential Responsible Party
PVC	Polyvinyl Chloride
QA/QC	Quality Assurance/Quality Control
RAS	Routine Analytical Services
RCRA	Resource, Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
SAP	Sampling and Analysis Plan
SAS	Special Analytical Services
S.S.	Stainless Steel
TAL	Target Analyte List
TAT	Technical Assistance Team
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TEF	Toxicity Equivalence Factor
TIC	Tentatively Identified Compound
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbon
USCS	Unified System Classification of Soils
USGS	United States Geological Survey
VAPE	Vermilion Association for Protection of the Environment

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0.0 EXECUTIVE SUMMARY

Remedial Investigation (RI) field activities for the PAB Oil and Chemical Services Superfund Site, (site location shown on Figure 1.2-1) were conducted from January 14, 1991 to March 29, 1991 (Phase 1) and from October 7, 1991 to October 31, 1991 (Phase 2). Initial Phase 1 RI field activities were conducted to evaluate the current overall environmental impact that has resulted from disposal activities that occurred during the period that the facility was in operation, late 1978 until early 1983. The subsequent Phase 2 RI field activities were conducted to further define the nature and extent of contaminant impacts as determined from the results of the Phase I RI field activities.

Section 1.0 of this RI report is an introductory section which contains background information on the PAB Oil site, including site description and history. Sections 2.0 through 5.0 contain discussions on the activities that were carried out during both the Phase 1 and 2 RI field investigations, as well as the results of the investigation.

A baseline risk assessment (BRA) was prepared to evaluate the potential adverse health effects resulting from human exposure to hazardous substances found to be present at the site (LSI, 1993a). The results of the BRA are summarized in Section 6.0. BRAs determine adverse health effects for those populations which are most likely to be exposed. For the PAB Oil site these are:

- Current on-site trespassers.
- Current off-site residents (adults and children)
- Future on-site residents farmers (adults and children).

The pathways by which these populations would be exposed to site contaminants were determined to be:

- Ingestion of and dermal contact with contaminated surface soil, sludge and sediments.
- Ingestion of homegrown vegetables, beef and milk raised in contaminated soil or sludge.
- Ingestion of groundwater, along with dermal contact with water (while bathing) and inhalation exposure to VOCs released from groundwater to indoor air.
- Dermal exposure to surface water in pits, ponds, marshes and ditches.

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Given exposure pathways, potential adverse health effects for each likely population are determined by the BRA for both carcinogenic risks and noncarcinogenic risks. The carcinogenic risk resulting from exposure to a chemical is described in terms of the probability that an individual exposed for his or her lifetime will develop cancer. Typically, cancer risks of $1E-06$ (one in a million) or lower are considered to be so small that they are of no practical concern. Higher cancer risk levels may be cause for concern. Site remediation is typically required by the United States Environmental Protection Agency (EPA) if cancer risks exceed $1E-04$ (one in ten thousand). Noncarcinogenic risks are determined by comparing a calculated intake with an acceptable intake for each chemical of concern and for each pathway that contributes to a population's exposure. The ratio of the calculated intake versus the acceptable intake is termed the hazard index (HI). The EPA has established that a HI of greater than one indicates the possibility that noncancer health affects may occur and that site remediation may be necessary.

In addition, an environmental baseline risk assessment was conducted to evaluate risks to environmental species (LSI, 1993b). The results of this assessment are summarized in Subsection 6.6.

The main site features or potential contaminant source areas that were identified and investigated as part of the RI field activities include three open waste impoundments or pits (northwest pit, northeast pit and south pit) and their associated berms, two other impounded areas referred to as the saltwater pond or large pond and the northwest saltwater pond or the northwest pond, four aboveground storage tanks and their associated underlying soils, site drainage/runoff areas (Route 167 ditch and site access road ditch), an adjacent abandoned canal, which borders the eastern edge of the site and other areas of suspected waste dumping (saltwater pond islands/mounds and northwest pond mound).

Additionally, on-site and off-site subsurface geologic and hydrogeologic conditions and contaminant impacts to groundwater were investigated through the drilling of soil borings and the installation of groundwater monitoring wells. The locations of the soil borings, monitoring wells and other site features are shown on Figure 1.2-2. The pertinent findings of the RI activities, as they relate to overall contaminant impacts and risk to human health, are summarized in the following paragraphs.

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Surface Waters and Sediments

In addition to the surface waters in the disposal pits, the PAB Oil site contains surface water in the saltwater pond (or large pond), the northwest pond and an abandoned canal at the eastern edge of the property. The majority of precipitation runoff from the site, including overflow from the ponds and the pits, drains to the west in the ditches on both sides of the site access road. Flow continues along the road to the State Route 167 drainage ditch. During the investigation, the surface waters (Figures 2.2-1 and 2.2-3) and sediments (Figures 2.2-1, 2.2-2 and 2.2-3) were investigated to evaluate the past and current migration of contamination.

The saltwater pond has overall dimensions of approximately 765 ft by 430 ft with an average liquid depth of 2 ft. A deeper area was discovered in the northeast corner measuring 95 ft by 125 ft and having an overall depth (water and sediment) near 7.5 ft. The total volume of water within the saltwater pond is approximately 4,500,000 gallons.

The northwest pond measures approximately 165 ft by 175 ft with varying depths from 2 ft to 11 ft. The water volume in the pond was calculated to be approximately 800,000 gallons.

The canal is no longer utilized and is dead-ended at several locations in the area of the site. Water, therefore, currently does not flow and the water level present in the canal is solely dependent on local rainfall. The water in the canal segment adjacent to the site has been observed to be nonexistent as well as over 3 ft in depth depending on the time of year.

Water samples collected from the canal showed no evidence of organic or inorganic contamination.

The canal sediment samples indicated low levels of several organic compounds such as 4-methyl-2-pentanone, benzoic acid and benzo(a)pyrene. There were no detectable levels of TCL pesticides or PCBs found in the canal sediment samples. The only inorganic parameter detected in the sediment samples, which was outstanding compared to background values, was mercury detected at 0.20 mg/kg.

The majority of contamination detected in the saltwater ponds' sediments occurred in samples located in the southeast corner of the saltwater pond at or near the suspected discharge pipe from the south pit. At this discharge pipe, the sediment was oily and black in color and had a distinct petroleum odor.

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The only non-laboratory suspected volatile organic contamination appeared in the form of TICs. On the other hand, many semivolatile organic compounds were detected. Most of the compounds detected were PAHs. The highest concentrations reported were for 2-methylnaphthalene (5,670 $\mu\text{g/kg}$), phenanthrene (2,750 $\mu\text{g/kg}$) and fluorene (1,070 $\mu\text{g/kg}$). Elevated levels of naphthalene, pyrene and chrysene were also detected along with a large number of semivolatile TICs.

No pesticides or PCBs were detected in the pond sediments.

The dioxin and furan analysis reported that there was no 2,3,7,8-TCDD detected. Two different dioxin isomers were detected in seven of the nine samples analyzed, however, due to the low values and the lower relative toxicities of the isomers detected, none of the samples had a toxicity equivalence to 2,3,7,8-TCDD greater than 0.01 $\mu\text{g/kg}$.

The most significantly elevated inorganic parameter detected in the pond sediments was barium. Elevated barium levels were detected throughout the pond sediments. The highest value recorded was 9,860 mg/kg barium detected in a sediment sample collected from the southeast corner of the saltwater pond. The southeast corner also reported elevated levels of calcium, chromium, cobalt and zinc.

There were no volatile organic compounds detected in the pond water samples which were not suspected to be attributable to laboratory contamination. The only TCL semivolatile reported was one PAH at a low concentration. There were, however, numerous semivolatile TICs detected.

Various pesticides were detected at very low concentrations in the pond water samples. There were no PCBs detected.

The highest TOC, COD and TPH values detected in the pond waters were 30.5, 86 J and 1.25 mg/l , respectively.

Several inorganic elements were detected in the pond water samples at elevated levels compared to off-site ditch samples and canal samples. The highest concentrations of barium and chromium were detected at 2,890 and 34.8 $\mu\text{g/l}$, respectively. Calcium, sodium and chloride were also reported at elevated values. Filtered (passing 0.45 micron) samples were also collected and they revealed a significant decrease in the concentration of many metals. The filtered results showed a 47% reduction in the barium level, down to 1,380 $\mu\text{g/l}$, and the chromium level was reduced to 9.1 $\mu\text{g/l}$. Although not considered elevated in the unfiltered sample, the levels of aluminum, iron, lead, magnesium, manganese and potassium also showed a decrease in concentration in the filtered sample. The calcium and sodium levels, however, showed no filtered reduction.

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In general, the barium and chloride site drainage ditch sediment concentrations are the highest near the outfall/overflow from the saltwater pond and decrease as the ditch proceeds to the west toward Route 167 (Figures 2.2-1 and 2.2-2). The highest detected barium and chloride concentrations were 4,030 and 1,257 mg/kg, respectively. The surface water concentrations of barium, calcium, chloride and sodium were also detected at higher values in the drainage ditches on-site than they were in the off-site Route 167 ditch, immediately after the confluence of the site runoff.

As mentioned before, the filtered sample results of the pond waters indicated a high suspended solids content of contaminants in the draining/overflowing pond water. This provides an explanation to the decreasing barium and chloride concentrations in the sediment as the drainage ditch progresses toward Route 167. The suspended solids (and their accompanying levels of contamination) drop out of solution into the underlying sediment as the velocity of the drainage water decreases as it progresses further and further away from its origin.

Soils

On-site and off-site soils were characterized through the collection of a number of depth discrete soil samples. The off-site soil borings/samples were utilized to obtain a range of representative background soil concentrations (Figure 2.1-1). The on-site soils samples were compared against these off-site values (Figure 1.2-2). The on-site soil investigation was concentrated in areas of suspected contamination such as the former tank battery, areas adjacent to the disposal pits (soil borings) and the saltwater pond islands/mounds.

Besides providing contaminant impact information, the soil borings adjacent to the pits and the borings, which were drilled for the installation of five new site monitoring wells, provided information on the stratigraphy underlying the site. The surficial topsoil, consisting of dark brown organic clay, ranges down to about 2 ft. A brown and gray clay horizon lies under the surficial soils and extends down to approximately 23 ft beneath the surface. The next unit extends down to approximately 25 ft and consists of sandy silt and silty clay. This unit is a transition zone between the upper clay unit and its underlying water sand bearing unit. This underlying sand unit coarsens downward as it extends to depths of at least 110 ft. Water was present in the sand unit at approximately 30 ft below the ground surface.

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The majority of the contamination detected in the on-site soils occurred in the former tank battery soils (Figure 2.3-8). There were, however, some elevated values, primarily inorganic constituents, detected in the pond island/mound soils and the soil borings adjacent to the disposal pits. The most significantly elevated parameters, compared to background, were arsenic, barium, beryllium, calcium, chloride, cobalt, lead, mercury and nickel.

The organic compounds detected in the visually stained tank soils revealed hydrocarbon contamination. The only volatile organic compounds detected, other than TICs, were ethyl benzene and total xylenes. Various semivolatile organics, however, were detected. These were primarily PAHs which included phenanthrene, fluoranthene and fluoranthene isomers, pyrene and chrysene. A large number of semivolatile TICs were also detected in the tank soils.

No pesticides or PCBs were detected in any of the off-site soils. Several pesticides were detected on-site at low concentrations.

TPH values for the tank soils were found to be elevated above background levels. The TPH values were found to generally decrease with depth. The highest reported TPH value was found in a surface sample at 18,110 mg/kg. Chloride concentrations, although not significantly elevated above background, were found to increase with depth rather than decrease. This is possibly due to the relatively high solubility of chloride compounds.

The dioxin and furan analysis performed on the tank soils revealed the presence of some dioxins. 2,3,7,8-TCDD, however, was not detected nor were any furans. A total of four dioxin isomers were detected nine times in the eleven samples analyzed. Two samples reported toxicity equivalence to 2,3,7,8-TCDD greater than 0.01 $\mu\text{g/kg}$, however, no tank soil sample had an equivalence greater than or equal to 1.00 $\mu\text{g/kg}$.

The concentrations of inorganic compounds (metals) in the tank soils were evaluated against background soil levels to determine whether the tank soil concentrations of these compounds were elevated. The predominant inorganic compounds which were found to be elevated in the tank soils were arsenic, barium, calcium, chromium, lead, magnesium, nickel, potassium, silver, sodium and zinc.

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Waste Disposal Pits

The three waste disposal pits (northwest pit, northeast pit and south pit) were probed to determine their depth and their contents. There was no liquid found in the northwest pit, but the probing revealed an average sludge depth of approximately 16 ft. Clay was present under the sludge at 16 ft. The estimated sludge volume of the northwest pit is 9,200 cubic yards. The majority of the northeast pit contained liquid down to approximately 7.5-8 ft, which was underlain by about 7-7.5 ft of sludge. A clay bottom was reached at 15 ft below the water surface. The estimated volume of liquid in the northeast pit was 1,300,000 gallons with an estimated sludge volume of 5,400 cubic yards. The northeast pit also contained a paraffin layer of scum which floated on the water surface at thicknesses up to 3 inches. The south pit contained primarily liquid with depths ranging from 9-14 ft. The thickness of the sludge on the bottom of the pit varied from 6 inches to 2 ft. The estimated volume of liquid in the south pit was 1,300,000 gallons with an estimated sludge volume of 900 cubic yards.

The pit sludge and underlying clay/soil were studied by collecting numerous depth discrete samples from at least four locations in each disposal pit. The sludge from the northwest and northeast disposal pits were similar in appearance, being described as a brown to gray/black sludge with a noticeable petroleum odor. The south pit sludge also had a noticeable petroleum odor, but its appearance was described to be a soupier and blacker material than that of the other two pits. The clay/soil underlying the pits typically had a hydrocarbon odor which varied from slight to strong. Some of the upper clay/soil samples had a visible dark, oily liquid in the pore spaces.

Numerous volatile and semivolatile organic compounds, typical of petroleum type constituents, were detected in the sludge samples from the three disposal pits. The following compounds were the predominant organic contaminants detected in the pit sludges. The values presented are the greatest concentration detected in each pit.

	<u>NW Pit</u> mg/kg	<u>NE Pit</u> mg/kg	<u>S Pit</u> mg/kg
<u>Volatile Organic Compounds</u>			
Benzene	6.6 J	42	7.5 J
Toluene	27.0 J	145	11.5 J
Ethyl Benzene	15.0 J	80	6.5 J
Total Xylenes	75.0 J	325	40

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	<u>NW Pit</u> mg/kg	<u>NE Pit</u> mg/kg	<u>S Pit</u> mg/kg
<u>Semivolatile Organic Compounds</u>			
Naphthalene	200 J	200	7.4 J
2-Methylnaphthalene	540 J	455	50 J
Fluorene	55 J	61	6.0 J
Phenanthrene	95 J	180	7.8 J
Pyrene	4.3 J	20 J	2.3 J

Analysis of the sludge samples by the Toxicity Characteristics Leaching Procedure (TCLP) for target compound list (TCL) organic parameters showed that no compound in any of the sludge samples from the three disposal pits exceeded the TCLP regulatory levels as listed in the Code of Federal Regulations, Title 40, Part 261 (40 CFR 261).

Sludge samples from each of the three waste pits were also analyzed for pesticides and polychlorinated biphenyls (PCBs). Sludge samples from the northwest pit and the northeast pit were found to contain low concentrations of several pesticides. One PCB, Aroclor-1260 was found to be present in two sludge samples collected from the northeast pit.

Sludge samples from each of the three pits were evaluated for chloride concentrations, total petroleum hydrocarbons (TPH) and pH. The sludge samples were found to have varying levels of each parameter. The south pit sludge reported the highest concentration of chloride at 66,900 mg/kg while the northeast pit recorded the highest TPH at 823,000 mg/kg (82.3%). The pH of the sludge ranged from 7.1 to 12.0.

Various dioxin isomers and one furan isomer were detected in the sludge samples collected from the three waste pits. Dioxin and furan isomers are evaluated according to a toxicity equivalence factor (TEF) which relates the toxicity of each isomer to that of 2,3,7,8-tetrachlorodibenzo-p-dioxin, which is the most toxic of the dioxin/furan isomers. A total of six sludge samples reported toxicity equivalence to 2,3,7,8-TCDD above 0.01 µg/kg, however, no sample had an equivalence greater than or equal to 1.00 µg/kg.

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Numerous inorganic compounds (metals) were detected in the sludge samples from the three disposal pits at concentrations which exceeded background soil levels. The following metals, proceeded by their greatest detected level within each pit, were the predominant inorganic contaminants detected in the pit sludges:

	<u>NW Pit</u> mg/kg	<u>NE Pit</u> mg/kg	<u>S Pit</u> mg/kg
<u>Inorganic Compounds</u>			
Arsenic	25.1	13.5 J	7.5 J
Barium	46,500	48,400	7,450
Cadmium	11.8	7	Undetected
Calcium	32,000	24,100	16,600
Chromium	933 J	857	136
Copper	685 J	111	15.4
Lead	2,780 J	585	32.4 J
Mercury	2.6	3.4	0.4
Zinc	3,610 J	2,560	1,510

None of the metals analyzed by TCLP for target analyte list (TAL) inorganic parameters exceeded the regulatory levels as listed in 40 CFR 261.

The clay soils beneath the pits and a floating paraffin layer (scum) on the northeast pit were found to contain many of the same compounds that were detected in the waste pit sludges, although at lesser concentrations.

The highest cancer risk relating to exposure to the waste pit sludges, as evaluated in the BRA, was found to be for future on-site residents with a total excess cancer risk of $2E-02$. The highest noncancer risk relating to exposure to the waste pit sludges was found to be for future on-site resident children with a HI of $3E+01$.

The disposal pit liquids (waters) were studied by collecting a surface and a subsurface composite water sample from both the northeast and south pits. Both the organic and inorganic analyses for the pit waters reflected elevated values compared to the off-site ditch and canal waters and the on-site ditch and saltwater pond waters.

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The predominant volatile organic contaminants detected in the pit waters are common fuel constituents. Benzene, ethyl benzene, toluene and total xylenes (BETX) were detected at maximum levels of 200 J, 56 J, 78 J, and 190 J $\mu\text{g/l}$. The benzene value exceeded its maximum contaminant level (MCL) of 5 $\mu\text{g/l}$. The solvents 1,1-dichloroethane and tetrachloroethene and a relatively high value of acetone were also detected.

The semivolatile organic analysis revealed the presence of several methylphenol isomers and various polycyclic aromatic hydrocarbons (PAHs) such as naphthalene, 2-methylnaphthalene, fluorene, phenanthrene and chrysene. Various semivolatile tentatively identified compounds (TICs) were also detected such as substituted benzenes, phenols and naphthalenes.

Total organic carbon (TOC) and chemical oxygen demand (COD) were reported at substantially higher values in the disposal pit waters than those reported for the site ditches and saltwater ponds. The highest TOC and COD values were 258 and 1,200 mg/l, respectively.

The pesticide/PCBs analysis performed on the pit waters detected various pesticides at low concentrations.

The inorganic sample results from the pit waters detected antimony, barium, beryllium and chromium at levels of 93.3, 13,000, 2.5 B and 99.7 $\mu\text{g/l}$, respectively. As a reference, the MCL for antimony is currently being proposed at 10 or 5 $\mu\text{g/l}$ while the MCLs for barium, beryllium and chromium are currently 2,000, 1.0 and 100 $\mu\text{g/l}$, respectively. Many other inorganic parameters, including arsenic, copper, zinc and chloride were detected at levels which were elevated compared to other site waters.

During the field investigation, the outer pit berm, which encompasses the three disposal pits, was evaluated and appeared very sound. There was no visual evidence of present seepage, past spillage or overflows.

The pit berm material was characterized by collecting eight soil samples and comparing the analytical results against background soil values. Both the organic and inorganic analyses reflect relatively uncontaminated material in the circumferential berm except on the inside of the berm at the northwest corner of the northwest pit (Figure 2.3-7), where there appears to be some residual sludge or other petroleum product present. This location revealed semivolatile TICs and TPHs as well as numerous inorganic compounds such as barium, cadmium, calcium, chromium, lead, mercury and zinc at levels above

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background soil concentrations. The levels at which these contaminants were present were significantly lower than the concentrations detected in the pit sludges, however, the concentrations present indicate an impact from site activities.

Storage Tanks

During the Phase 1 field work, the four aboveground storage tanks were sampled and investigated to determine the quantity and type of material present and the condition of the tanks. Based on the sampling results obtained and the physical condition of the tanks, a group of potential responsible parties (PRPs) entered into an Administrative Order on Consent (AOC) with EPA to conduct an emergency removal action on the storage tanks and their contents. As a result of this emergency removal action, the tanks and their contents were removed from the site. This activity occurred during the same time frame as the Phase 2 field investigation, therefore, additional characterization was not needed.

Groundwater

The groundwater at the site was evaluated through monitoring and collection of groundwater samples for analysis (well locations are shown on Figure 2.4-1). A total of twelve monitoring wells were sampled and monitored during the RI field investigations. Monitoring wells, MW-9, MW-10 and MW-12 are either upgradient and/or considered to be sufficiently removed from the site as to represent background water quality conditions. Additionally, ten residential water supply wells were sampled during the RI.

Groundwater beneath the site was encountered at approximately 30 ft below the ground surface in the upper Chicot Aquifer System. The groundwater flow direction under the site was found to be generally west-northwest with a gradient of 0.0002 ft/ft. Both of these observations of the local groundwater flow are consistent with regional flow conditions.

There were no significant, positively identified contaminant trends resulting from the analytical results of the groundwater samples. There were, however, some contaminants present at elevated levels at individual locations. The elevated constituents were primarily metals (barium, chloride, chromium, lead, nickel, etc.).

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The only significant organic compound detected was benzene. It was detected twice at levels less than its MCL of 5 $\mu\text{g/l}$. It was reported in MW-5 and MW-7 at values of 3 J and 2 J $\mu\text{g/l}$, respectively. Seven pesticides were detected at trace amounts during Phase 2 of the RI, but none of these were detected during Phase 1.

The total metals analysis reported chromium and lead at levels higher than their current drinking water standards. Chromium was reported at its highest concentration of 1,330 $\mu\text{g/l}$, which is well above its MCL of 100 $\mu\text{g/l}$, and lead was reported at its highest concentration of 141 $\mu\text{g/l}$, which is above the promulgated "action level" of 15 $\mu\text{g/l}$. Antimony, beryllium and nickel were also detected above newly promulgated MCL values.

Obvious differences in the concentrations of metals existed between the total and dissolved (filtered) groundwater samples. The filtered chromium and lead concentrations were at or below 12.6 and 1.0 $\mu\text{g/l}$, respectively. Nickel, on the other hand, maintained its high, elevated total metals concentrations in the filtered samples as well. Nickel's maximum values were reported at 659 $\mu\text{g/l}$ in its total and 317 $\mu\text{g/l}$ in its filtered analysis. Other constituents, considered to be elevated in the total metals analysis, such as aluminum, antimony, barium, beryllium and chloride, had their concentrations dramatically reduced when the samples were filtered.

An off-site, upgradient background monitoring well, MW-10, revealed high concentrations of numerous metals. The maximum values reported in any of the site monitoring wells for barium and lead were detected in this well. Other metals detected at high levels in the background well include aluminum, chromium and zinc.

The residential water supply wells (ten total) sampled during the RI apparently have not been impacted by contaminants from the PAB Oil site. These residential wells did not show evidence of elevated concentrations of any target compound or analytes that could be directly related to the site.

The most noticeable result from the residential water analysis was the arsenic results. Arsenic was detected in every residential well at concentrations up to 30.5 $\mu\text{g/l}$ (arsenic MCL is 50 $\mu\text{g/l}$). The source of these elevated values remains unknown. It is evident that they are not related to past operations at the site. The site's highest level of arsenic was 10.7 $\mu\text{g/l}$. Additionally, the two residential wells reporting the highest values are located south-southwest of the site, which is not in a downgradient position.

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The BRA evaluated human health risks from ingestion of groundwater. Estimated cancer risks to future on-site residents is $3E-04$, with arsenic and beryllium contributing most to that risk. Excess noncarcinogenic risks (HIs greater than 1) from ingestion of groundwater were also found, with antimony, arsenic, chromium, nickel, and vanadium contributing most to that risk.

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Section I

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1.0 INTRODUCTION

1.1 PURPOSE OF REPORT AND ORGANIZATION

In July of 1990, the U.S. Environmental Protection Agency (EPA), Region VI, requested that Sverdrup Corporation (an EPA contractor under the Alternative Remedial Contracting Strategy -ARCS - Program) perform a Remedial Investigation/Feasibility Study (RI/FS) of the PAB Oil and Chemical Services Superfund Site located in Vermilion Parish, Louisiana, hereafter referred to as PAB Oil or the site. The purpose of the remedial investigation (RI) is to establish the nature and extent of contamination at the site and to gather all necessary data to support the feasibility study. The purpose of the feasibility study (FS) is to identify, develop and evaluate remedial action alternatives for the site contaminants. This RI report presents the results of the characterization studies that have been conducted at the site.

This report is organized to provide information on site history and background information in this introductory Section 1.0, the field activities associated with this site characterization in Section 2.0, the physical characteristics of the study area in Section 3.0 and the results of the site characterization in Section 4.0. The environmental fate of the contaminants identified is discussed in Section 5 and a summary of the human health and environmental baseline risk assessments are provided in Section 6.0. References are provided in Section 7.0. Additional information is contained in the appendices. It should be noted that figures are included in Appendix I and RI data summary tables are included in Appendix II.

1.2 SITE BACKGROUND

1.2.1 Site Description

The PAB Oil site is located less than 3 miles north of Abbeville, Louisiana, adjacent to State Route 167, in Vermilion Parish, Section 12, T12S-R3E. The site consists of 16.7 acres that was used to receive and dispose of wastes associated with the oil and gas industry. Figures 1.2-1 and 1.2-2 (Appendix I) illustrate the location of the site and a site layout, respectively.

The property is located in a generally rural area with the surrounding property being chiefly agricultural with livestock grazing and crops. Residential use of property has increased however, along the major roadways in close proximity to the site.

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The site consists of three (3) impoundments or pits that were used to receive the wastes. The three pits are herein referred to as the northwest, the northeast and the south pits based on their location. The site also contains two other impounded areas commonly referred to as the saltwater pond or large pond and the northwest saltwater pond or the northwest pond. These areas are believed to have been used for receiving production waters during the years of operation.

The disposal pits are believed to have been operated in series, where the solids would settle out, oil would be skimmed off and the remaining water flowed to the next pit through a connecting pipe system. The flow was from the northwest pit to the northeast pit and then to the south pit. It is believed that the south pit then flowed into the southeast area of the saltwater pond. Overflow from the saltwater pond enters into the ditch(es) along side of the site access road and flows westward with the other site drainage, toward LA Route 167.

At the initiation of the RI, the site also contained three storage tanks located between the pits and the saltwater pond and a smaller fourth tank located between the saltwater pond and the northwest saltwater pond. These tanks and their contents were removed from the site during a removal action conducted by a group of potentially responsible parties (PRP) during the fall of 1991. This effort is further described in Section 4.3.9.

1.2.2 Site History

(The majority of Subsection 1.2.2 is summarized from "Final Report for Expanded Site Inspection - PAB Oil and Chemical Services, Inc." Ecology and Environment, Inc., 1988.)

PAB Oil and Chemical Services, Inc. (PAB Oil) operated a disposal facility for oil field drilling muds and salt water from late 1978 till early 1983. As part of its normal operations, PAB Oil reportedly sold to reclaimers the waste oil skimmed from the oil-based drilling mud separation/disposal pits.

PAB Oil began operations in late 1978 and operated under interim approval, granted by the Louisiana Department of Natural Resources (LDNR), Office of Conservation on September 25, 1979. The approval was granted under authority of Statewide Order 29-B, which regulates the drilling, production and operation of oil and gas wells in the state of Louisiana, including provisions for pollution control.

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On July 20, 1980, an amendment to Statewide Order 29-B, which established new requirements for off-site drilling mud and salt water disposal facilities, became effective. Existing facilities were granted temporary authority to operate, with 90 days to comply with new requirements.

At the same time, PAB Oil was notified that it needed a permit from the Office of Environmental Affairs in order to discharge treated water from the disposal pits into the surface water drainage system.

A citizen's complaint of discharge from the site into an off-site drainage ditch led to site identification by the EPA on June 27, 1980. As a result, site inspections were conducted by the EPA, the LDNR and the Louisiana Department of Environmental Quality (LDEQ). The Field Investigation Team (FIT) conducted a preliminary assessment and preliminary sampling inspection in 1980. "Notices of Violation" of Statewide Order 29-B were sent to the PAB Oil on December 4, 1980 by the LDEQ and on October 2, 1980 by the LDNR.

On January 8, 1981, the Vermilion Parish Police Jury and the Vermilion Parish Planning Committee at the urging of the Vermilion Association for Protection of the Environment (VAPE) requested that the LDNR deny PAB Oil's request for a permit to discharge treated oil field wastewater into Coulee Kinney via the Parish drainage system. PAB Oil was again notified of violations of Statewide Order 29-B on June 30, 1981 by the LDEQ and on March 30, 1982 by the LDNR.

PAB Oil was owned by Alex Abshire until February 1982, when it was reported as sold to a consortium headed by William H. Lambert and Jack Clothier. PAB Oil reported that it stopped receiving oil field waste in August 1982 because of its inability to meet the requirements of Statewide Order 29-B. Its interim authority to operate the disposal site was revoked by the LDNR on November 10, 1982 and PAB Oil was ordered to proceed with a closure plan for the site.

On January 12, 1983 PAB Oil was notified that the storage tanks and the gates to the facility had been sealed by agents of the LDNR, Office of Conservation, due to open leakage from pits and because an unknown party had placed petroleum waste in a tank at the site on or about January 10, 1983. All notices of violations from both departments were referred to the State Attorney General's office for prosecution in January 1983. Adjoining property owners had also filed private lawsuits against PAB Oil alleging salt water contamination of private water wells and surface property damage.

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In 1983 the company reportedly lacked the funds for a proper closure. It is now out of business and the wastes are still on-site. PAB Oil's lease was canceled in November 1984 and control of the property was returned to land owner Edmond Mouton.

The Technical Assistance Team (TAT) inspected the site on November 20, 1984 ("TAT Site Investigation at PAB Oil and Chemical", Roy F. Weston, 1984). The FIT also conducted comprehensive sampling on July 9 and 10, 1985 ("Memorandum - Sampling Inspection at PAB Oil and Chemical Services, Inc." Ecology and Environment, Inc., 1985).

In May, 1986, the FIT was tasked by the EPA to obtain additional information regarding location and description of the City of Abbeville water wells and the use of surface water in the vicinity of PAB Oil ("HRS Support Information Regarding PAB Oil and Chemical Services Co.", Ecology and Environment, Inc., 1986).

In 1987 the FIT performed an Expanded Site Inspection ("Final Report for Expanded Site Inspection - PAB Oil and Chemical Services, Inc.", Ecology and Environment, Inc., 1988).

The site was proposed to the National Priority List (NPL) in June 1988. The site was finalized on the NPL in March 1989.

1.2.3 Previous Investigations

As indicated in the previous section, Site History, the site has been under investigation since 1980. FITs and TATs have conducted initial preliminary assessments, sampling inspections and expanded site inspections during the time period between 1980 and August 1987. As part of the current RI/FS, the existing data base has been reviewed and a summary describing the results, data gaps and the useability of the information was submitted to EPA on August 6, 1990, as Technical Memorandum No. 10865G00(1.1)-3. This memorandum is included as Appendix III.

Section II

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2.0 STUDY AREA INVESTIGATION

The field activities that were performed as part of the Remedial Investigation were conducted in two phases, Phase 1 and Phase 2. Both investigations were conducted in accordance with the Work Plan, Sampling and Analysis Plans (SAPs) and Health and Safety Plan developed for the site. Samples collected for chemical analyses during the field activities were sent to laboratories participating in the U.S. EPA Contract Laboratory Program (CLP) as directed by the EPA Region VI laboratory in Houston, Texas or directly to the EPA laboratory in Houston for analysis. The samples collected for geotechnical analyses were delivered to Shannon & Wilson, Inc. of Creve Coeur, Missouri for analysis.

The field activities for Phase 1 were conducted from January 14 - March 29, 1991. The Phase 1 field activities included the following:

- Collection of off-site, background soil samples to identify concentrations of possible naturally occurring or "background" parameters to be utilized as a possible baseline level.
- Collection of site runoff and drainage sediment to evaluate current conditions of contaminants leaving the site and to evaluate remaining constituents from past discharges.
- Collection of water and sediment samples from the large saltwater pond, the northwest pond and the adjacent low area to characterize the material present. The investigation also collected depth measurements to develop volume estimates.
- Collection of water, sludge and clay samples from the disposal pits to characterize the material present and to evaluate the extent of contamination. Depth measurements were also collected to develop volume estimates.
- Collection of liquid and sludge samples from the storage tanks to characterize the material and to develop volume estimates. A composite soil sample from around the tanks was also collected.
- Screening of soil, sediment and sludge samples in the field for radiation using a hand held radiation meter. This was performed to check for potential naturally occurring radiation associated with oil and gas exploration and production.
- Monitoring air quality during field activities with an OVA or a HNU. The monitoring was performed as part of the routine health and safety procedures.

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- Drilling of five (5) borings adjacent to the disposal pits to define the depth of natural clay underlying them. The collection of soil samples for chemical characterization was also performed.
- Installation of monitoring wells in two (2) of the five (5) borings adjacent to the disposal pits.
- Collection of groundwater samples for chemical analysis.
- Review of the berms of the three disposal pits and the ponds for integrity. Erosion, seeps and overflows were evaluated.
- A door-to-door survey of wells in the immediate area of the site.

The field activities for Phase 2 were conducted from October 7 - October 31, 1991. The Phase 2 field activities included the following.

- Collection of additional off-site, upgradient surface water and sediment samples to establish background levels for detectable compounds near the site.
- Collection of additional site runoff and drainage sediment samples to further study current levels of contaminants leaving the site and to determine deposited constituents from past discharges.
- Collection of soil samples from the southeast marsh area to determine if the area has been impacted by contaminants from the disposal pits.
- Collection of soil samples from the mound in the northwest pond area and the islands (mounds) in the saltwater pond for chemical analysis. These mounds were suspected to be possible waste material.
- Visually examining the linear extent of contamination in the sediment and the collection of sludge/sediment/clay samples from the southeast corner of the saltwater pond for chemical characterization.
- Searching for the suspected interconnecting pipe(s) between the northeast and south pits and between the south pit and saltwater pond.
- Collection of sludge and clay samples from the disposal pits to further characterize the materials present. An effort was made through modified extraction procedures to achieve reduced detection limits thereby increasing the overall usefulness of the data.

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- Collection of sludge/soil samples from the disposal pit edges to allow an assessment of risks posed by direct exposure to the material along the pit edges.
- Collection of disposal pit berm soil samples to study the potential for past spillage and to characterize the material utilized to construct the berms.
- Collection of depth discrete soil samples to determine the vertical and linear extent of contamination resulting from past spillage from the storage tanks.
- Monitoring air quality during field activities with an OVA or HNU. The monitoring was performed as part of the routine health and safety procedures.
- Drilling three off-site soil borings to further define site stratigraphy. Soil samples were also collected to examine the background and downgradient levels of site contaminants.
- Collection of Shelby tube samples from the clay unit in two of the borings to study the geotechnical properties of the clay in the area of the site.
- Installation of monitoring wells in the three borings. One monitoring well (boring) is located upgradient while the other two are downgradient to the site.
- Collection of two rounds of groundwater samples - one initial and one final (after the completion of the three new monitoring wells). Chemical analysis was performed to examine background and downgradient levels of site contaminants.
- Collection of 10 residential well samples to assess the potable water quality in the vicinity of the site.

2.1 BACKGROUND SOIL INVESTIGATION

Four (4) off-site locations were selected during Phase 1 to obtain background soil samples (Figure 2.1-1). One location was selected from each side of the site, each located approximately 300 ft from the site fence. The north location is on agricultural property, the east and south location are on property used for cattle grazing and the west location is on property currently not being utilized and is grown over in grass.

Depth discrete samples were obtained from each location at depths of 0 - 0.5 ft, 1 - 1.5 ft, and 2.5 - 3 ft using a stainless steel hand auger. Samples were analyzed for target compound list (TCL) organic and target analyte list (TAL) inorganic parameters, including cyanide, chloride, total petroleum hydrocarbon (TPH) and pH.

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Two additional locations were sampled during Phase 2 that could be considered background. These are the locations of two borings that were utilized for the installation of monitoring well No. 10 (MW-10) and (MW-12). Due to its close proximity to the site and potential for impact from surface drainage, the location for (MW-11) is not being considered acceptable for use as a background location. The boring locations are shown on Figure 2.4-1. These samples are further discussed in Section 2.4.2.

2.2 SURFACE WATER AND SEDIMENT INVESTIGATIONS

2.2.1 Site Drainage/Runoff

Several days of rain were encountered during the Phase 1 field investigation which enabled an accurate determination of the surface runoff patterns. The majority of surface runoff from the site, including overflow from the saltwater ponds, drains to the west in the ditches on both sides of the site access road. Flow continues along the road to the Highway 167 drainage ditch. Flow then drains to the north. This site hydrology is shown in Figure 2.2-1 by flow direction arrows.

2.2.1.1 Route 167 Ditches

Three sediment (0 - 1 ft) and three water samples were collected during Phase 1 from the ditch along Hwy. 167 (Figure 2.2-1). The northern samples include all runoff leaving the site to the west, the middle location is south of the access road and excludes runoff entering from along the access road. The southern sample location is upstream from the site. During the Phase 2 investigation, additional surface water and sediment samples were collected along Route 167. These samples were collected to further define background levels for detectable compounds so that an accurate comparison could be made with the elevated levels found in the site drainage pathways during Phase 1. The three (3) locations selected in Phase 2 for the collection of surface water and sediment (0 - 0.5 ft) samples are shown in Figure 2.2-1.

All Phase 1 surface water and sediment samples were analyzed for TCL organics and TAL inorganics, including cyanide and chloride. The sediment samples were also analyzed for TPH and pH. The water samples were also analyzed for total organic carbon (TOC) and chemical oxygen demand (COD). Temperature, conductivity and pH were measured in the field.

The Phase 2 location south of the site access road is located at the same approximate location as the surface water and sediment samples collected in Phase 1. This enabled an evaluation of the variability of the surface water quality and the reproducibility of the

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previous sediment results. The Phase 2 west location is just prior to the culverts which drain surface water on the west side of Route 167 to the east under Route 167. The Phase 2 northern location is north of the confluence of water coming from the site, the water draining under Route 167 and the water draining from the south.

All Phase 2 water and soil/sediment samples were analyzed for TCL organics, TAL inorganics, chloride and TPH. The water samples were also analyzed for TOC. Temperature, conductivity and pH of the water samples were measured in the field.

2.2.1.2 Site Access Road Ditches

Two sediment and two water samples were collected during Phase 1 from the site access road ditches. A sediment and a water sample, Figures 2.2-2 and 2.2-3, was collected from both the north and south sides of the ditch where it drains off-site to the west.

All Phase 1 surface water and sediment samples were analyzed for TCL organics and TAL inorganics, including cyanide and chloride. The sediment samples were also analyzed for TPH and pH. The water samples were also analyzed for TOC and COD. Temperature, conductivity and pH were measured in the field.

Five (5) additional soil/sediment (0 - 0.5 ft depth) samples were collected during Phase 2 from the drainage ditch that drains the large pond and lies south of the site access road (Figures 2.2-2 and 2.2-3).

Two additional surface water samples were also planned, however during much of the Phase 2 investigation there was no water draining from the site. Samples were not collected later in the field work, following precipitation, because this occurred after a removal action on the site storage tanks and significant earth moving occurred which would have resulted in the samples not being representative of actual baseline site conditions.

The Phase 2 soil samples were analyzed for TCL volatile and semivolatile organics, TAL inorganics, chloride and TPH. Pesticides and polychlorinated biphenyls (PCBs) were not requested since detectable levels were not found previously in site soils or the pond sediments. However, two of the samples did receive pesticide/PCB analysis by the laboratory, therefore these results are included in the data tables. Additionally, three of the five soil/sediment samples were analyzed for dioxins and furans. This was done to study the extent of contamination in the event detectable levels were found in the pits or the pond sediments.

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During the Phase 1 and Phase 2 investigation, water samples were also collected from the saltwater ponds which discharge directly into the south site access road ditch. This sampling is further discussed in Section 2.3.1.

2.2.1.3 Southwest and Southeast Corners

The southwest corner of the property used to be the discharge location from the large pond. This discharge no longer occurs and drainage in the ditch that extends to the west is limited to runoff collected from off-site and the very southwest corner of the PAB site. A sediment sample was collected during Phase 1 to investigate the past discharge, however, sufficient surface water was not present to collect a water sample (Figure 2.2-2). The sample was analyzed for TCL organics, TAL inorganics, including cyanide, chloride, TPH and pH. This area was not further investigated in Phase 2.

Precipitation on the east side of the property drains to the south, collects and infiltrates the soil near the southeast corner. Runoff in this area was not observed leaving the property due to a system of berms constructed around the property edge. During the Phase 1 investigation, a sediment and a surface water sample were collected from this area (Figures 2.2-2 and 2.2-3). Both samples were analyzed for TCL organics, TAL inorganics, cyanide and chloride. The sediment sample was also analyzed for TPH and pH. The water sample was also analyzed for TOC and COD.

2.2.2 Southeast Marsh Area

Sediment and surface water samples were collected during Phase 1 from a marshy area located at the southeast end of the property, south of the south pit (Figures 2.2-2 and 2.2-3). Runoff from this area was not observed leaving the property but collects and infiltrates the soil. During Phase 1, the marshy area was viewed as a possible seep from the south disposal pit.

The Phase 1 surface water and sediment samples from the marsh area were analyzed for TCL organics and TAL inorganics, including cyanide and chloride. The sediment samples were also analyzed for TPH and pH. The water samples were also analyzed for TOC and COD. Temperature, conductivity and pH were measured in the field.

During the Phase 2 investigation, seven (7) soil samples, including one duplicate sample, were collected from the three locations shown on Figure 2.2-2. Two depth discrete samples were collected at each location, a 0 - 1 ft and 2 - 3 ft sample, in order to determine if the area has been impacted by the contaminants in the disposal pits. A surface water composite sample of the three locations was also to be collected, however,

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since this area was observed to be dry during most of the Phase 2 investigation, the idea of a possible seep area was discounted and an additional surface water sample following a rainfall event was not obtained. Additional discussion of this area is included in Section 3.3.

The Phase 2 soil samples were analyzed for TCL volatile and semivolatile organics, TAL inorganics, chloride, and TPH. Pesticides and PCBs were not analyzed for since detectable levels were not found in Phase 1.

2.2.3 Abandoned Canal

The surface water and sediment from the canal to the east of the site were sampled during Phase 1 at three separate locations; north, middle and south (Figures 2.2-2 and 2.2-3). The canal is no longer utilized and does not flow but it still collects runoff from the nearby fields. During summer months this canal has been observed to be dry, however during the investigation it contained over 3 ft of water. No visible runoff from the PAB site was observed to enter the canal due to the levee which borders its west side. There may, however, be some infiltration into the area from collected surface waters on the PAB site.

The sampling was conducted to investigate any impacts from this possible infiltration and to investigate the possible past disposal of material into the canal. Three (3) surface water and sediment samples were collected. The soil sediment samples were taken from the 0 - 1 ft depth range.

The Phase 1 surface water and sediment samples were analyzed for TCL organics and TAL inorganics, including cyanide and chloride. The sediment samples were also analyzed for TPH and pH. The water samples were also analyzed for TOC and COD. Temperature, conductivity and pH of the water samples were measured in the field.

This area was not further investigated during Phase 2.

2.3 CONTAMINANT SOURCE INVESTIGATIONS

Seven potential contaminant source areas were examined during the field activities. These were the saltwater pond, the northwest saltwater pond, the northwest disposal pit, the northeast disposal pit, the south pit, the disposal pit berms and the storage tanks and surrounding soils.

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2.3.1 Saltwater Pond

This pond has an irregular, rectangular shape. Site surveys indicate that the rectangular body has overall dimensions of approximately 765 ft by 430 ft. The average liquid depth of the pond is approximately 2 ft. A deeper area was discovered in the northeast corner where it appears a deeper excavated pit was at one time. This northeast part measures approximately 95 ft by 125 ft with a liquid depth of 4.5 ft. The total volume of water contained in the pond is approximately 4,500,000 gallons.

The pond was probed to estimate the depth of sludge and sediment. The southeast corner of the pond was found to contain sediment varying in depth from 3 inches to approximately 3.5 ft. The northeast corner was found to have 2.9 ft of sediment at the portion believed to have been excavated for a deeper pit. Sediment was measured at the center of the pond to be approximately 1 ft and the western portion of the pond contained approximately 6 inches of sediment. Only that material at the southeast corner was noticeably discolored or contained a detectable petroleum odor.

During the Phase 1 investigation, several sediment and surface water samples were collected from the main body of the saltwater pond. A surface water sample and a duplicate surface water sample were collected using a high density polyethylene (HDPE) beaker. The sample was composited from four different locations: southwest, northwest, southeast, and northeast areas of the pond. A sub-surface sample was collected by using a subsurface grab sampler. This sample was composited from the same four locations as the surface water samples. Four sediment samples were also collected at these same 4 locations with a S.S. hand auger. The samples collected from the southwest and northwest areas of the pond were taken from the top 1 ft of sediment. The sample collected from the southeast corner of the pond was collected from the 1 - 2 ft depth. The sample collected from the deeper pit area, in the northeastern corner of the pond, was collected from the 1.5 - 2.5 ft depth of sediment. The sampling locations are shown in Figures 2.2-3 and 2.3-1.

All saltwater pond samples collected during Phase 1, were analyzed for TCL organics, TAL inorganics, cyanide, chloride, and pH. The liquid samples were further analyzed for TOC, COD, temperature, and conductivity. The sediment samples were also analyzed for TPH.

During the Phase 2 investigation, the sampling effort was concentrated toward two areas within the large body of the saltwater pond. The southeast corner of the pond and the pond islands (mounds) were examined in greater detail. The southeast corner was studied by probing and collecting samples to determine the extent of the visually

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contaminated, black sludge/sediment and to search for a possible piping connection between the pond and the south disposal pit. The pond islands were sampled to find out if they were, at one time, used as disposal mounds and characterize any waste material that may remain.

2.3.1.1 Southeast Corner

A low water level in the south disposal pit revealed, what appeared to be, a six inch drainage pipe in the southwest corner of the pit. Probing the pipe determined that it was most likely no longer intact because the pipe was loose. The positioning of the pipe also provided evidence that it was no longer intact. The estimated length of the detached pipe, approximately 6 ft, was not perpendicular with the berm bank, but parallel.

The finding of the pipe in the south pit, although seemingly detached, gave reason to believe that the pipe was once connected and it provided subsurface flow through the berm and into the saltwater pond. The believed outflow end of this subsurface piping system was detected approximately five feet off the bank in the saltwater pond. It was under about 2 ft of water disallowing a detailed description. The pipe did, however, seem solid and intact.

Probing the sediment in the vicinity of the outflow pipe revealed a black, oily sludge. The sludge/sediment seemed to be 0.5 - 1 ft thick. As probing continued radially outward from the discharge point, the discoloration and odor decreased.

Three separate measurements of the water level elevations of the south pit and saltwater pond, shot by a registered surveyor, also provide evidence leading toward the connection between the two impoundments. The three water elevations, shot in March, October and December of 1991, provide differences between the saltwater pond and south disposal pit of +0.2 ft, -0.4 ft and zero ft, respectively.

The evidence provided by the finding of the drain pipes, the presence of the sludge and the minimal differences in water level elevations provide a good indication of the impoundments' interconnection. When this information is coupled with the knowledge that, with significant rainfall, the south pit never overflows or even rises in elevation beyond a certain point, there is sound basis to believe there is flow from the south pit to the saltwater pond.

The extent of the sludge was examined by probing the bottom of the pond and by collecting material in a teflon scoop starting near the bank and extending outward until the visually contaminated material was not noticeable. A total of nine samples were

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collected from this area (Figure 2.3-1). Two samples were collected within the visually contaminated zone - a sediment and a clay (1.7 - 2.7 ft in depth). Seven other sediment samples, including one duplicate sample, were collected radiating outward in direction from the black, visually contaminated zone. All sediment samples were collected from the surface to 1 ft in depth and taken to help define the extent of non-visual contamination that was detected in the Phase 1 sample.

The sediment/clay samples from the southeast corner of the saltwater pond were analyzed for TCL volatile and semivolatile organics, TAL inorganics, chloride and TPH. Pesticides and PCBs were not analyzed for as detectable levels were not found in Phase 1. The sediment/clay samples were also analyzed for dioxins and furans. This was performed to check for the possible past disposal of unknown chemical wastes at the site.

2.3.1.2 Islands/Mounds

The islands (raised soil mounds) in and near the saltwater pond were investigated by collecting soil samples, including two duplicate samples, at the nine locations shown in Figure 2.3-2. These areas were suspected to be waste material that was deposited during past site operations. The samples were collected with a S.S. hand auger. At each location a surface (0 to 1 ft) and subsurface (2 - 3 ft) sample was collected and analyzed for TCL organic compounds, TAL inorganic compounds, TPH and chloride.

2.3.2 Northwest Pond

The overall dimensions of the pond, based on site surveys, are approximately 165 ft by 175 ft. The center and northern parts of the pond were found to vary in depth from 6.5 - 11 ft. The southern part of the pond, referred to as the low area, had a liquid depth of approximately 2 ft. The low area of the pond has been observed to dry during the summer months. Since the pond is in a low area it receives surface runoff from the site access road ditch. The volume varies seasonally and on the amount of precipitation received. During the Phase 1 investigation, the pond contained approximately 800,000 gallons of water. Probing of the pond was performed to measure the depth of sediment. The sediment in the center portion of the pond was found to be approximately 2 ft in depth and the low area has approximately 0.75 ft of sediment. The material was visually a brown soil/sediment and no discoloration or petroleum odor was detected.

Surface water and sediment samples were collected from the northwest pond during the Phase 1 field investigation. The sample locations are shown on Figures 2.2-3 and 2.3-1. The water sample, collected from the low area, was a composite of the surface water and subsurface water at the 2 ft depth. The sample was obtained by compositing the surface

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water, collected with a HDPE beaker, and subsurface water collected with a subsurface grab sampler. A sediment sample was collected at this same location by compositing three S.S. hand auger samples from the sediment surface to the 1 ft sediment depth.

A surface water sample, collected with a HDPE beaker, and a subsurface water sample, collected with a subsurface grab sampler, were also collected from the center portion of the northwest pond. Both of these samples were a composite of two different locations, the west side and the east side of the pond. A sediment sample was collected from the west side of the pond by compositing three S.S. hand auger samples from the sediment surface to the 1 ft sediment depth. A sediment sample and a duplicate sediment sample was collected from the east side of the pond by compositing four S.S. hand auger samples from the sediment surface to the 1 ft sediment depth.

The Phase 1 samples from the northwest pond were analyzed for TCL organics, TAL inorganics, cyanide, chloride, and pH. The liquid samples were further analyzed for TOC, COD, temperature and conductivity. The sediment samples were also analyzed for TPH.

The only part of the northwest pond area that was studied during Phase 2 was an elongated soil mound located in the northeastern corner of the area. The mound measures approximately 4 ft high by 10 ft wide by 15 ft long and was investigated to evaluate the potential that it contained waste material from past site operations.

Four soil samples were collected at two locations (Figure 2.3-1) from the soil mound. At each location a surface (0 - 1 ft) and deep (2 - 3 ft) sample were collected using a S.S. hand auger. Both locations were on the side of the mound approximately 2 or 3 ft above grade. The listed depths of the samples are not vertical depths, they are depths measured perpendicular to the mound surface angled in toward the center of the mound. The samples were analyzed for TCL organic compounds, TAL inorganic compounds, TPH and chloride.

2.3.3 Northwest Disposal Pit

The sludge and underlying clay were sampled from the northwest disposal pit at the locations shown on Figure 2.3-3. Prior to sampling, the pit was probed to determine the depth of its contents. No liquid was present, but the probing revealed an average sludge depth of approximately 16 ft. The dimensions of the pit are approximately 85 ft by 255 ft with an approximate sludge volume of 9,200 cubic yards. A cross-section of this pit can be seen in Figure 3.4-2 which is one of three site cross-sections discussed in Section 3.4-2. The sludge was a soupy, brown/gray material with a noticeable petroleum odor.

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During Phase 1, samples were collected from the northwest disposal pit at three different locations; north, middle, and south. The collection of the samples was performed by placing a 4 inch polyvinyl chloride (PVC) pipe down through the sludge into the clay and obtaining the sample with a S.S. hand auger from inside the pipe casing. Sludge samples were collected at the north location at depth intervals from 0 - 2 ft, 7 - 9 ft and 14 - 15.5 ft. Underlying clay samples were collected at this location at depth intervals of 16 - 16.5 ft and 18 - 18.75 ft. At the middle location, sludge samples were obtained from the top 6 inches and the 11.5 - 14 ft depth with a duplicate sample taken at the 11.5 - 14 ft depth. Clay samples were collected at this middle location from the 15.5 - 16.25 ft depth and the 18 - 19 ft depth with a duplicate sample collected at the 18 - 19 ft depth. Sludge samples were obtained from the south location at depths of 4 - 5 ft, 9.5 - 10.5 ft and 14 - 15 ft. Clay samples were obtained at this location at 16.5 - 17.5 ft and 19 - 20 ft depth intervals.

All sludge and clay samples collected in Phase 1 from the northwest pit were analyzed for TCL organics, TAL inorganics, cyanide, chloride and pH. The sludge samples were also analyzed for flash point, heat of combustion and were tested by the toxicity characteristic leaching procedure (TCLP). The TCLP extract was analyzed for TCL organics and TAL inorganics.

One additional location was sampled in the northwest pit during the Phase 2 investigation. The location, shown on Figure 2.3-3, lies in the center of the pit between the Phase 1 north and middle locations. The procedure used to collect the samples was the same as in Phase 1. Five (5) discrete sludge samples were collected from 3 - 4 ft, 5 - 6 ft, 7 - 8.5 ft, 9 - 10 ft and 11 - 12 ft with a duplicate sample collected at 7 - 8.5 ft. Two (2) clay samples were collected from 15.5 - 17 ft and 17.5 - 18.5 ft with a duplicate sample taken at 15.5 - 17 ft.

Due to the presence of high levels of oily, long chain hydrocarbons found in all three pits during Phase 1, the achievable detection limits were elevated relative to "normal" thereby reducing the usefulness of the Phase 1 data. In an effort to reduce the interference encountered in the Phase 1 semivolatile and pesticide/PCBs analyses, the Phase 2 samples were analyzed by Special Analytical Services (SAS) procedures utilizing modified extraction/clean-up methods. The SAS procedures utilized were methods from the 3rd edition of SW 846. Semivolatiles were extracted utilizing method 3650, cleaned using method 3611 and analyzed using the Contract Laboratory Procedure (CLP) Protocol for Organics, 3/90 SOW. The pesticides/PCBs were extracted utilizing method 3650, cleaned using method 3620 and analyzed using the CLP Protocol for Organics, 3/90 SOW. The volatiles were analyzed utilizing CLP Information for Bid protocol.

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As a check on the modified procedure, two (2) of the "cleaner" sludge samples and one (1) clay sample, were also analyzed by the standard Routine Analytical Services (RAS) procedure for TCL organics. The samples were also analyzed for TAL inorganics, TPH, chloride and dioxins and furans. The dioxin and furan analysis was conducted to examine the potential presence of the compounds as a result of any past disposal of chemical wastes not related to oil field activities.

All four of the northwest pit locations sampled during Phase 1 and Phase 2 were secured from the possibility of vertical migration of contaminants. When all of the samples were collected from each location, bentonite pellets were placed down the hole and brought up to a level above the top of the clay. The pellets were then hydrated and the top of the 4 inch PVC pipe was securely covered to prevent precipitation from entering the pipes.

In addition to collecting sludge and clay samples from within the northwest pit, two (2) composite sludge/soil samples were collected from the edge of the pit to assess risks posed by direct exposure to the material along the pit edge. A grab sample was also collected from the pit edge. The two composite samples, north and south, were composited from 3 sample locations (Figure 2.3-4). The sample collected at each location was taken from the surface to approximately five (5) inches in depth. The samples were collected with a S.S. spoon and composited in a S.S. bowl. The north composite was also taken as a duplicate sample. Each composite sample was analyzed for TCL organics, utilizing the modified extraction procedures, TAL inorganics, TPH and chloride. The grab sample was only analyzed for TCL organics, utilizing the modified extraction procedure.

2.3.4 Northeast Disposal Pit

During the site investigation, surface water, sludge, underlying clay and floating scum samples were collected from the northeast disposal pit. Sample locations are shown in Figure 2.3-5. Prior to sampling, the pit was probed to determine the depth of water and sludge in the pit. The results of the probing revealed that the liquid depth in the pit is approximately 7.5 - 8 ft deep with a 7 - 7.5 ft layer of sludge. Clay is beneath the sludge at approximately 15 ft. The only exception found was the northeast corner which had a liquid depth of 5.5 ft with a 2 ft layer of sludge. A cross section of the pit can be seen in Figure 3.4-4. The estimated volume of liquid in the northeast pit is 1,300,000 gallons with an estimated sludge volume of 5,400 cubic yards. The overall dimensions of the pit are approximately 100 ft by 260 ft. A floating scum layer, varying in thickness from 0.5 - 3 inches, covered approximately half of the pit. This scum layer moves along the water surface depending upon the wind direction.

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During Phase 1, a composite sample was collected from the scum layer by collecting several grab samples at different locations. This floating scum layer sample was analyzed for TCL organics, TAL inorganics, cyanide, flash point, heat of combustion, viscosity and percent ash. A composite surface water sample was collected with a HDPE beaker by compositing grab samples from three different locations, southeast corner, southwest corner and the center of the pit. The northern end of the pit was not sampled so as to not disturb the scum layer, which on the day of sampling, was at the north end. A composite subsurface water sample was collected with a subsurface sampler at a depth of 6 ft by compositing grab samples taken from the same three locations as the surface water sample. Both surface water and subsurface water samples were analyzed for TCL organics, TAL inorganics, cyanide, chloride, TOC and COD. Temperature, pH and conductivity were measured in the field. The locations of the scum sample and the water samples are shown in Figures 2.3-5 and 2.2-3, respectively.

The sludge and underlying clay samples from the northeast pit were obtained by placing a 4 inch PVC pipe through the water column through the sludge and into the underlying clay. This pipe was used as a casing. The water column inside the casing was removed and the sludge and clay were sampled with a S.S. hand auger. This procedure was performed at three different locations during Phase 1; north, middle and south as shown in Figure 2.3-5. At the south location, two sludge samples were collected at 9 - 10.5 ft and 11.5 - 13.5 ft depths. A clay sample was collected at the 15.5 - 17 ft depth. At the middle location, a sludge sample and a duplicate sludge sample was collected at the 8 - 11 ft depth interval. An additional sludge sample was collected at the 12 - 13 ft depth. Clay samples were collected at the 15 - 16.5 and 18 - 19 ft depth intervals. At the north location, two sludge samples were collected from the 8 - 10 ft and 12 - 13 ft depth intervals. Two clay samples were obtained at the 16 - 17 ft and 18 - 19 ft depth intervals. The upper clay samples from the middle and north locations had a visible dark oil in the pore spaces in addition to a petroleum odor.

All Phase 1 sludge samples obtained from the northeast pit were analyzed for TCL organics, TAL inorganics, cyanide, TPH, pH, chloride, flash point and heat of combustion. The sludge samples were also tested by the TCLP. The extract was analyzed for TCL organics and TAL inorganics. The middle sludge sample at the 12 - 13 ft depth was further analyzed for viscosity and percent ash. All underlying clay samples were analyzed for TCL organics, TAL inorganics, cyanide, TPH, pH and chloride. The middle clay sample at the 15 - 16.5 ft depth was further analyzed for flash point and heat of combustion.

One additional sampling location from the northeast pit was selected for the Phase 2 field operations. The location, shown on Figure 2.3-5, lies near the center of the pit between

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the Phase 1 north and middle locations. The Phase 1 sampling procedure was repeated for Phase 2. Six (6) sludge samples, including a duplicate from 10 - 11.5 ft, were collected along with two (2) underlying clay samples. The first three sludge samples were collected from 8 - 9.5 ft and 10 - 11.5 ft. The fourth sludge sample was taken at an interval of 9.5 - 10.5 ft from the surface. At this point, it is believed that the combination of an air pocket in the casing and intrusion of sludge into the bottom of the casing started lifting the sludge toward the surface, hence the higher sample interval of this fourth sample. The downward sampling progression continued after the casing was firmly seated into the clay. Two (2) additional sludge samples were collected from 11.5 - 12.5 ft and 13 - 14 ft. The two (2) clay samples were collected from 15 - 16 ft and 16.5 - 17.5 ft.

The sludge and clay samples collected from the northeast pit during Phase 2 had the same set of analyses run on them as were run on the Phase 2 northwest pit samples.

All four of the northeast pit sampling locations were secured against the vertical migration of contaminants. Bentonite pellets were added down the casings and then they were hydrated. The casings were tightly covered, as was done to the casings in the northwest pit, to prevent the entrance of any precipitation.

Two (2) composite sludge/soil samples were collected from the edge of the northeast pit to assess the risks posed by direct exposure to the pit's edge. A grab sample was also collected from the pit edge. The north and south composite samples were each composited from 3 sample locations (Figure 2.3-4). The sample collected at each location was taken from the surface to approximately 4 - 5 inches in depth with a S.S. spoon and bowl. Each composite sample was analyzed for TCL organics utilizing the modified extraction procedures, TAL inorganics, TPH and chloride. The grab sample was only analyzed for TCL organics, utilizing the modified extraction procedure.

2.3.5 South Disposal Pit

The surface water, sediments and the underlying clay were sampled from the south disposal pit as shown on Figures 2.2-3 and 2.3-6. The overall dimensions of the pit are approximately 90 ft by 220 ft. Prior to sampling, the pit was probed to determine the depth of water and any underlying sludge. The results of this probing revealed that the water levels in the northern and center portions of the pit are approximately 14 ft deep. The southern part of the pit has an average water depth of 9 ft. The thickness of the sludge on the pit bottom varied from 6 inches in the southeast to 2 ft in the western part of the pit. The northeast section and north center section varied in sludge thickness from 1 - 1.5 ft. The estimated volume of liquid in the south pit is 1,300,000 gallons with an

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estimated sludge volume of 900 cubic yards. The sludge in the south pit was not visually similar to the other disposal pit sludges. It was a "soupier", blacker material and a noticeable petroleum odor was present. A cross-section of the pit is shown in Figure 3.4-2.

During Phase 1, a composite surface water sample was collected with a HDPE beaker by compositing two grab samples, taken from the east and west sides of the pit. A composite subsurface water sample was collected with a subsurface grab sampler from a depth of approximately 14 ft by compositing grab samples taken from the same two locations as the surface water samples. Five (5) sludge samples were collected with a stainless steel dredge sampler from four different locations as shown on Figure 2.3-6. A sludge sample and a duplicate sludge sample were collected from the northeast corner of the pit. Sludge samples were also collected from the southwest corner, northwest corner and north-center locations. Underlying clay samples were collected with a stainless steel hand auger from the northeast corner, north-center, northwest corner and southwest corner at the 0 - 1 ft depth of clay. A duplicate clay sample was collected from the southwest corner at a 2-2.5 ft depth interval of clay. Because clay samples were obtained through the sludge layer, the extracted clay was scraped of any visual sludge and the exterior clay was cut away prior to the bottling of material that was used as the samples.

All of the Phase 1 samples collected from the south pit were analyzed for TCL organics, TAL inorganics, cyanide and chloride. The surface water samples were further analyzed for TOC and COD. Temperature, pH and conductivity were measured in the field. Sludge and clay samples were also analyzed for TPH. In addition, the sludge samples were analyzed for flash point, heat of combustions and they were tested by TCLP. The extract was analyzed for TCL organics and TAL inorganics.

During the Phase 2 field investigation, two (2) composites of the south pit bottom sludge were collected. Clay samples were not needed in Phase 2 because low level analysis and acceptable detection limits were achieved on the south pit clay samples during Phase 1. Each of the two composite samples, an east and a west, were composited from three sample locations as shown in Figure 2.3-6. The sludge samples were collected with a stainless steel hand auger from the bottom of the pit.

Two (2) composite sludge/soil samples were also collected from the south pit edge. The two samples, east and west, were each composited from three sample locations (Figure 2.3-4). Each sample was taken from the surface to approximately 3 - 4 inches in depth with a S.S. spoon.

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The analyses run on the Phase 2 south pit samples were identical to the analyses run on the Phase 2 pit sludge and pit edge soil/sludge samples, collected from the northwest and northeast pits.

2.3.6 Disposal Pit Berms

The berms which encompass the three disposal pits were studied during the field investigations. The integrity of the berms was examined for such things as erosion, seeps, overflows and breaks. The berms were also surveyed so that an estimate of the berm volumes could be made. The berm soils were also sampled to characterize the material utilized to construct the berms and to study the potential for past spillage and/or seepage.

The pit berms appeared very sound. Erosion has been minimal due to the presence of vegetation. There is no visual seepage. A former suspect seepage area, the southeast marsh area, was studied and discussed in Section 2.2.2. The pit berm near the southeast marsh area remains dry and is intact. There is no evidence of any past spillage or overflows. There is, however, one break in the berm that separates the northwest and the northeast pits. It is believed to have been placed there intentionally, after the northwest pit was filled with sludge, to allow the collected rainwater from the northwest pit to drain into the northeast pit. The break occurs near the center of the berm length between the two pits.

The berm volumes were estimated from survey data. The estimates were calculated on the volume of material above grade elevation which is approximately 20 - 21 ft above mean sea level (MSL). The two longest berm sections, the east and the west berms, are composed of approximately 1,170 and 1,280 cubic yards of material, respectively. The north and south berm sections contain approximately 700 and 410 cubic yards of material, respectively. The two inner berms are composed of lesser volumes of material. The central berm consists of 120 cubic yards while the east-west berm consists of 130 cubic yards. The total volume of material for the entire berm system is 3,810 cubic yards.

The berm soils were sampled to characterize the material as contaminated or not and to assess the risks posed if contamination is present. Due to the common wall construction of the pits and the minimal volume of the two inner berms, only the outer berms were sampled. The Phase 2 SAP stated that six (6) composite soil samples would be taken from the outside edges of the berms. A field modification resulted in the collection of eight (8) samples. Four (4) samples were collected on the outside of the berms to examine the potential for past spillage while four (4) additional samples were collected

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inside the berms to characterize the construction material and to study the impact of the pit contaminants on the berms.

Each of the four numbered sampling locations, shown on Figure 2.3-7, actually consist of two composite samples; one from the outside and one from the inside of the berm. Each of the eight composite samples was collected from three grab sample locations. The grab samples were taken at the mid-height elevations of the berms from the surface to 6 inch depth range. The samples were taken with a stainless steel hand auger, composited in a stainless steel bowl and placed into the appropriate sample containers. The samples were analyzed for TCL organics, TAL inorganics, TPH and chloride.

2.3.7 Storage Tank Contents

At the initiation of the RI investigation, four storage tanks were located on site. Three tanks were located together in a diked area between the salt water pond and the northwest pit. These tanks were identified as the horizontal tank, middle tank and east tank. A fourth tank located between the northwest pond and the saltwater pond was identified as the "tank by pond". The location of these tanks are shown on Figures 1.2-2.

During the Phase 1 field work, the tank contents were investigated to determine the quantity and type of material present. Based on the sampling results obtained and the physical condition of the tanks, a group of PRPs entered into an Administrative Order on Consent (AOC) with EPA to conduct an emergency removal action on the storage tanks and their contents. As a result of this emergency removal action, the tanks and their contents were removed from the site. This activity occurred during the same time frame as the Phase 2 investigation, therefore, additional sampling and characterization of the tank material was not necessary during Phase 2.

The horizontal tank was approximately 27 ft long and 9 ft in diameter with a capacity of 12,800 gallons. The tank had an open port hole in the top approximately two feet in diameter. Contents of the tank was estimated at 750 gallons and appeared to be water with a floating oily scum layer on top. An immeasurable amount of solids were on the bottom. An area of past or current discharge from the tank was not observed. Samples were collected by lowering a laboratory sample bottle attached to a S.S. auger extension down through the top port hole opening. Difficulty was encountered in obtaining a sample of the water phase without obtaining the oily scum layer and vice versa. Initially one sample was collected containing both phases. This was sent to the lab as a high concentration sample. The laboratory separated the sample into phases and upon screening, the water phase was deemed low level and the field team was informed that additional sample volume of the water would be needed for organic analysis. The water

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phase was therefore resampled later in the field investigation. Samples were analyzed for TCL organics, TAL inorganics, cyanide, flash point, specific heat, ash content and viscosity.

The middle tank was approximately 14.9 ft high and 12 ft in diameter with a capacity of 12,600 gallons. The tank had a port hole on the top approximately 8 inches in diameter. Contents of the tank was estimated at 880 gallons and appeared to be water with a thick floating scum layer on top. An immeasurable amount of solids were on the bottom. It appears that as rainwater entered the tank from the access ports on the top, the volume in the tank was kept at a constant level by leakage from the valve located near the bottom of the tank. During the Phase 1 field investigation, as temperatures increased, the scum layer was observed to "melt" and also drain from the valve of the tank. Samples were collected by lowering a laboratory sample bottle attached to a S.S. auger extension down through the top port hole opening. Difficulty was encountered in obtaining a sample of the water phase without obtaining the hard scum layer and vice versa. Two samples were collected with the majority of one being water and the other one scum. Samples were analyzed for TCL organics, TAL inorganics, cyanide, flash point, specific heat, ash content, viscosity. The scum sample was also tested by the TCLP extraction procedure and the extract was analyzed for TCL organics and TAL inorganics.

The east tank was approximately 21.5 ft high and 11.5 ft in diameter with a capacity of 15,000 gallons. The tank had a domed top and bottom with a port hole on the top of the tank approximately 18 inches in diameter. The port hole was partially covered by a rotten plywood cover, however it was not reusable following sampling. The opening was covered with a drum lid at the end of sampling. Contents of the tank was estimated at 10,500 gallons and appeared to be water on the bottom and at least 3,000 gallons of oil in the top phase. No detectable layer of sludge was identified in the tank, however, during the PRP led removal action, approximately 4000-5000 gallons of a thicker sludge-like material was discovered in the tank. The material was still of low enough viscosity to be pumpable, which is believed why the probing of the tank contents during Phase 1 did not detect the different phase of material. A discharge to the surrounding soils was not observed. Samples were collected from the top, middle and bottom of the tank during Phase 1. The top and middle samples were collected with a peristaltic pump and the bottom phase was sampled with a subsurface grab sampler. This tank was sampled in Level C protection since HNU readings at the opening of the tank were 30 ppm. Just inside the tank the level was 80 ppm. Samples were analyzed for TCL organics, TAL inorganics, cyanide, flash point, specific heat, ash content and viscosity.

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The tank by the pond was approximately 7 ft long and 30 inches in diameter with a capacity of 250 gallons. The tank was lying at an angle horizontally and appeared to have been discarded at this location. The contents of the tank was estimated to be 85 gallons with a thin layer of oil on top and a bottom layer of a thick sludge/oil mixture. A port hole located on the tank side approximately six inches in diameter was used to sample the contents. A discharge to surrounding soils was not observed. Samples were collected with a small diameter glass drum thief. Samples were analyzed for TCL organics, TAL inorganics, cyanide, flash point, specific heat, ash content and viscosity. A sample was also tested by the TCLP extraction procedure and the extract was analyzed for TCL organics and TAL inorganics.

2.3.8 Tank Soils

During Phase I, a composite soil sample was collected from the soil next to the three tanks located in the diked area between the saltwater pond and the northwest pit. The sample was collected by hand augering at four different locations to a depth of six inches and compositing all soils into one sample. The four locations for the sample were collected near fill or drain valves on the tanks. The locations are shown on Figure 2.3-8. This sample was analyzed for TCL organics, cyanide, TAL inorganics, TPH, pH and chloride.

Following the removal action on the storage tanks, a series of soil samples were collected from the diked area as shown on Figure 2.3-8. Samples were collected from areas adjacent to valve locations on the tanks, locations from under the tanks, from areas adjacent to the tanks to evaluate the extent of contamination, if detected, and from drainage paths away from the diked area. The diked area actually drains to the west through a pipe which directs surface runoff, including the discharge from the large pond, to the south access road ditch.

The tank soil samples were analyzed for TCL volatile and semivolatile organics, TAL inorganics, chloride and TPH. Pesticides and PCBs were not analyzed for since detectable levels were not found in the Phase I samples. Dioxin and Furan analysis was also included on several of the samples to evaluate the presence of these compounds resulting from the potential past disposal of chemical wastes.

A single grab tank soil sample was also taken during Phase 2 from the area of the small tank by the northwest pond (Figure 2.3-1). During the removal action, approximately one gallon of material spilled during the removal of the tank. Visually contaminated soil and vegetation was removed by the removal contractor for disposal with the tank contents. A sample was collected of the remaining surface soil to evaluate the

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effectiveness of the soil removal. The sample was analyzed for TCL volatiles and semivolatiles, TAL inorganics, chloride and TPH.

2.4 GEOLOGICAL INVESTIGATION

2.4.1 Stratigraphy/Chemical Investigation

During Phase 1, five soil borings, designated SB-1 through SB-3, MW-8 and MW-9 (locations on Figure 1.2-2), were drilled to define the soil stratigraphy at the site and to collect soil samples to determine the level of the soil's contamination, if any. The primary importance of the borings was to define the soil stratigraphy by the disposal pits and to convert MW-8 and MW-9 into monitoring wells so that the groundwater in the immediate vicinity of the disposal pits could be analyzed.

The borings ranged from 25.0 - 45.0 ft in depth and were drilled by a Mobile B-57 drill rig. The borings were sampled continuously using a 5 ft long, 3 1/2 inch inside diameter (ID) continuous core sampler until groundwater was encountered at approximately 32 ft below ground surface. The descriptions of the soils were logged in the field by a geologist. In those borings extending below the piezometric surface (MW-8 and MW-9), the continuous core sampler was used as a "plug" by wedging a teflon cap into the bottom of the sampler to prevent sand from heaving into the hollow-stem augers. Therefore, no soil samples were collected from the water surface down to the termination of the borings at 45.0 ft below ground surface.

At each boring location soil samples were collected at the 0 to 1 ft and 2 to 3 ft intervals. The samples were analyzed for TCL organics and TAL inorganics, along with cyanide, TPH, chloride and pH.

Three soil borings, designated MW-10, MW-11 and MW-12 (locations on Figure 2.4-1), were drilled during Phase 2. These borings were drilled off-site to further define the soil stratigraphy near the site, determine the background and downgradient levels of the possible soil contaminants and to convert the borings into monitoring wells so that the background and downgradient groundwater could be analyzed.

The descriptions of the soils were logged in the field by a geological engineer. The borings were drilled with a Central Mine Equipment (CME) 55 drill rig. The borings were sampled continuously using a 5 ft long, 3-1/2 inch ID continuous core sampler until groundwater was encountered (approximately 27 - 28 ft below ground surface). As in Phase 1, there were no samples obtained below the piezometric surface because the

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continuous core sampler was capped with a teflon "plug" to prevent the sandy formation from heaving up into the hollow stem augers. The borings were terminated at 40.0 ft.

Soil samples were collected for chemical analysis at each boring location at the 0 - 1 ft and 2 - 3 ft depths. Three additional soil samples were collected from each boring with the primary emphasis on evaluating the "background" metals concentrations of the clay unit beneath the disposal pits. The individual samples depths were varied depending on the unique stratigraphy of each boring. The additional sample depths were as follows: MW-10 -- 5.0 - 6.5 ft, 10.0 - 11.0 ft and 17.0 - 18.0 ft; MW-11 -- 5.0 - 6.0 ft, 10.0 - 11.0 ft and 15.0 - 16.0 ft; MW-12 -- 9.0 - 10.0 ft, 14.0 - 15.0 ft and 16.4 - 17.4 ft. The samples were analyzed for TCL organics and TAL inorganics, along with TPH and chloride. Cyanide and pH were not analyzed in Phase 2 because the Phase 1 sampling consistently reflected the lack of detectable cyanide and extreme values of soil pH.

2.4.2 Physical Investigation

During Phase 2, soil samples were collected for physical analysis (geotechnical properties) at boring locations MW-10 and MW-11. Two Shelby tubes were collected from each boring, one tube from the upper and one tube from the lower part of the clay unit. All four Shelby tube samples were analyzed for water content, Atterberg limits and cation exchange capacity (CEC). In addition, one sample from each boring was selected to be analyzed for particle size distribution (hydrometer analysis), dry density and hydraulic conductivity.

2.5 GROUNDWATER INVESTIGATION

2.5.1 Monitoring Wells

Two monitoring wells (MW-8 and MW-9) were installed during Phase 1 along the eastern property boundary (locations shown in Figure 1.2-2). Three off-site monitoring wells (MW-10, MW-11 and MW-12) were installed during Phase 2; one to the east of the site, one to the west and one near the western property boundary (locations shown in Figure 2.4-1). The monitoring wells are constructed of 2-inch ID, Schedule 40, PVC casing with 2-inch ID, 0.01 inch machine slotted PVC well screens. All down-hole equipment and well construction material were decontaminated with high-pressure steam wash prior to use.

Monitoring wells MW-8 through MW-12 were installed across the piezometric surface, with the screened intervals ranging in depth from 22.7 to 42.8 ft below ground surface. Well construction diagrams are provided in Appendix V.

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The monitoring wells were developed with PVC and/or teflon bailers. The bailers were used to swab the well screen and remove fines from the filter pack. At least five well volumes were removed from each well during development. If any water was used during well installation, a volume equivalent to the amount used was also purged. Because of the installation water used in MW-8 and MW-9, approximately 70 gallons and 100 gallons, respectively, a pneumatic pump was utilized to aid in the development process of these two wells.

Three complete rounds of water sampling for chemical analyses were collected from the monitoring wells. MW-8, MW-9 and the previously existing seven monitoring wells were sampled in Phase 1 during March of 1991. The same nine wells were sampled at the beginning of Phase 2 in early October of 1991. The third round of sampling was also performed during Phase 2, but it occurred during late October of 1991. This last sampling effort included MW-8, MW-9, the seven previously existing monitoring wells and the three newly installed monitoring wells, MW-10, MW-11 and MW-12.

Prior to sampling, the water level and total depth of each well were measured, and a minimum of three well volumes of water were removed using decontaminated bailers. The samples from all of the wells during each sampling round were field analyzed for temperature, pH and conductivity. The laboratory analysis of the groundwater samples collected during Phase 1 included TCL organics, TAL inorganics, cyanide, COD, TOC, chloride, alkalinity and hexavalent chrome. The chemical analyses of both groundwater sampling rounds during Phase 2 included TCL organics, TAL inorganics, TOC, TPH, chloride and alkalinity. All of the Phase 2 samples were analyzed for both total and dissolved inorganics. The dissolved inorganic samples were filtered in the field. TPH was added for Phase 2 because Phase 1 data revealed some tentatively identified compounds (TICs) in the TCL organics analysis for both the disposal pit and the monitoring well samples. COD was excluded in Phase 2 because Phase 1 did not reflect any significantly elevated numbers. Cyanide and hexavalent chrome were also excluded in Phase 2 because the Phase 1 data consistently reflected the lack any detectable values.

Two additional monitoring wells were planned to be installed during Phase 2, but EPA was unable to obtain permission from the applicable land owners. Both wells were planned to be off-site wells, located south of the property boundary. One well was to be located approximately 250 ft south of the southeast corner of the site. The other well was to be placed just south of the site approximately midway between the east and west property boundaries. These locations were selected to further define the site stratigraphy and soil contaminants from the borings and to provide additional groundwater information, such as site groundwater flow and potential groundwater contamination.

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2.5.2 Residential Wells

2.5.2.1 Well Survey

During the Phase 1 investigation, a door-to-door survey was conducted to investigate the occurrence of residential and irrigation wells in close proximity to the site. The survey was initially structured to obtain specific information on the wells, however, it became apparent that specific documentation on well construction was not available. Most owners could only provide estimates on the depths, age and construction of their wells. This became evident when the information obtained from several of the well users was compared to the well boring logs obtained from the Louisiana Department of Transportation and Development and the United States Geological Survey (USGS).

The results of the survey, which can be found in Appendix VII, indicate that there are more than 55 residential wells within an approximate 1/2 mile radius of the site. The majority of the wells are along State Route 167 and Parish Road P-3-26 south and east of the site. The majority of the wells are estimated to be between 90 and 120 ft deep. The survey also revealed two irrigation wells. One of these wells is eight inches in diameter, approximately 250 ft deep and is located approximately 900 ft north-northwest of the site. The depth of the other is unknown and is located approximately 2,400 ft west-northwest of the site. Both were pumping during the Phase 1 investigation, being utilized to flood rice fields and crawfish ponds. Neither of these irrigation wells were being employed during the Phase 2 activities.

Although the well survey did not provide complete, accurate information on the wells, it did provide information on the location of potential sample locations. None of the persons talked to had any problems with allowing the collection of samples from their wells at a future date.

2.5.2.2 Well Sampling

During Phase 2, ten of the surrounding residential wells were sampled. The wells, both downgradient and upgradient, from the site were sampled to assess the potable water quality in the area. The sampled wells are shown in Figure 2.5-1 and are indicated by #'s, 5, 8, 13, 21, 39, 41, 44, 45, 52 and 55. Physical and ownership information for the wells is provided in Appendix VII.

The selection of the wells was based on location as well as the reported depth and age of wells. The concerns about their water quality, expressed by several of the residents during the Phase 1 residential survey, was also a deciding factor in selecting one well

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over another in a particular area. Residents were contacted prior to sampling to coordinate the effort.

The residential well samples were analyzed for TCL organic and TAL inorganic parameters, chloride, TOC, alkalinity and TPH. Temperature, pH and conductivity were measured in the field.

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3.0 PHYSICAL CHARACTERISTICS OF THE STUDY AREA

3.1 SURFACE FEATURES

The PAB Oil Site consists of about 16.7 acres with approximately 82% of the site being utilized as pits/ponds and related berms or levees. The site and surrounding area is flat and has a general surface elevation of slightly below +20 ft MSL.

The top of the disposal pit berms range in height from approximately 5.3 - 6.2 ft above grade, while the berm around the large saltwater pond ranges from 3-5 ft above grade. The site itself has a levee around the majority of the property, ranging from 4 ft to the east along the former irrigation canal, to 1-2 ft along the remainder of the site.

The physical features of the disposal pits, ponds and disposal pit berms were investigated during the field work and the findings were discussed in the individual subsections of Section 2.0.

3.2 METEOROLOGY AND CLIMATE

The region has an average annual temperature of 20°C, with temperatures ranging from highs of 38°C in July and August to lows of -7°C in December and January (U.S. Department of Commerce, 1984). Rainfall in the area averages 59 inches per year, with a mean average annual lake evaporation rate of 48-50 inches per year (Vander Leeden, et. al., 1990, Nyman, et. al., 1990.)

The 25 most recent months of precipitation data for the Abbeville, Louisiana area was obtained from the National Climatic Data Center (NCDC). Table 3.2-A summarizes the

NCDC data by reflecting the precipitation recorded for each month and the total annual precipitation for 1990 and 1991. The annual rainfall during 1990 was approximately 12 inches below the 59 inches per year average, while the rainfall during 1991 exceeded the average by about 31 inches.

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TABLE 3.2-A
 LOCAL PRECIPITATION DATA
 FROM JANUARY, 1990 TO JANUARY, 1992
 UNITS: INCHES

Month	1990	1991	1992
January	3.63	12.81*	12.90
February	6.09	6.64*	--
March	5.45	5.79*	--
April	2.87	9.19	--
May	7.59	10.66	--
June	1.68	12.17	--
July	2.04	7.99	--
August	2.49	7.10	--
September	6.09	7.16	--
October	2.65	6.35**	--
November	1.65	1.23	--
December	4.44	2.50	--
Total	46.67	89.59	--

Area Average = 59 inches (Vander Leeden, et. al., 1990, Nyman, et. al., 1990)

*Phase I Field Investigation Under Way

**Phase 2 Field Investigation Under Way

Compiled from: The National Climatic Data Center's information for the Abbeville, Louisiana area.

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3.3 SURFACE WATER

Several days of rainfall were encountered during the field investigations which enabled an accurate determination of the site's surface water runoff direction. The majority of surface runoff from the site, including overflow from the saltwater ponds, drains to the west in the ditches on both sides of the site access road. Flow continues along the road to the State Route 167 drainage ditch. Flow then drains to the north along Route 167 for approximately 70 ft before it turns eastward. The surface water flows eastward for approximately 160 ft back toward the site before it starts to deviate from its eastward direction and head in a northern direction, away from the site (Figure 2.2-1).

The only other area where surface water was viewed leaving the property was the southwest corner. This area used to have been the discharge location from the saltwater pond, however, this no longer occurs and runoff is limited to that water draining from the very southwest of the property.

The southeast of the property contains a marshy area south of the south pit and a drainage ditch that divides part of the levee west of the former irrigation canal. Both of these areas collect runoff but neither currently discharge due to an additional levee that has been constructed across what may have been their former path. The ditch dries following a rain, infiltrating into the soil. The marshy area remains wet for the majority of the year supporting marsh type vegetation such as cattails. After Phase 1, this area was viewed as a possible seep area from the south disposal pit because the area was never seen dry, but the Phase 2 investigation negated that idea because the entire "marsh" area was found to be dry at the initiation of the field work. Surface runoff from the site was not observed entering the old irrigation canal.

The northeast area of the site does not contain an established drainage path and the overland flow that does occur drains to the west, to the site access road ditches.

The precipitation that enters the northwest pit, resulting in overflow, spills into the northeast pit through an opening in the berm between the two areas. Water then flows to the south pit from the northeast pit through an interconnecting pipe. From the south pit it is believed that the water then flows to the saltwater pond through a connecting pipe.

Although the flow from the south pit to the saltwater pond has never been confirmed, it is believed that, at one time, the impoundments operated in this manner and that the connection still exists. During Phase 1, visually contaminated, black sediment/sludge was found in the very southeastern corner of the saltwater pond. During Phase 2, as

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mentioned in Section 2.3.1, a drain pipe was found in each pit. The south pit has been observed to never overflow or rise beyond a certain point. These observations, combined with the fact that surveyed elevations of the water levels in the two pits were nearly the same on several different occasions, strongly support the belief that the two impoundments are interconnected.

The saltwater pond overtops a low berm/spillway in the southwestern part of the former tank battery (Figure 1.2-2). The discharge exits the bermed tank area through a drainage pipe which leads to the site access road drainage ditch. The saltwater pond overflow proceeds westward along the south road ditch unless the discharge exceeds the capacity of the ditch in which case, some of the flow runs over the access road to the north road ditch and progresses westward along with the flow in the south road ditch.

3.4 GEOLOGY

3.4.1 Regional Geology

The site is located within unconsolidated sediments of the Atlantic-Gulf Coastal Plain physiographic province. These sediments are of Pleistocene age and were deposited by the ancestral Mississippi River that derived sediment and flow from the central part of the North American Continent (Nyman, 1984). The sediments were deposited in a complex series of alternating beds of sand, gravel, silt and clay. The beds dip toward the south and southeast and vary in thickness from less than 100 ft in southwestern Louisiana to more than 7,000 ft beneath the Gulf of Mexico (Harder, et al., 1967).

3.4.2 Site Area Geology

The site's subsurface environment was investigated in Phase 1 by drilling five exploratory borings. These borings were drilled for the purposes of collecting samples for chemical analyses and lithologic descriptions. Soil borings SB-1 through SB-3 ranged in depths from 25.0-30.0 ft below ground surface. Each of these borings were grouted to the surface with a bentonite/portland cement grout following completion. Borings MW-8 and MW-9 were drilled to a depth of 45.0 ft below ground surface and completed as monitoring wells. Both monitoring wells were constructed with 15 ft PVC screens which intersect the groundwater surface. The locations of these five borings are shown in Figure 1.2-2.

The subsurface environment of the site was further investigated during Phase 2 by drilling three more exploratory borings, MW-10, MW-11 and MW-12, which are located in Figure 2.4-1. Not only were the additional borings drilled to further define the site

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stratigraphy as discussed in this section, but they were also to provide additional information on chemical analyses on the soil and groundwater (discussed in Sections 4.4 and 4.5) and to provide geotechnical analytical data (discussed in Section 3.4.3) on the clay unit which supports the disposal pits.

The three Phase 2 borings were drilled to a depth of 40.0 ft below the ground surface. All three of the borings were completed as monitoring wells intersecting the piezometric surface with screens 15 ft in length.

All soil borings were sampled with a 5 ft continuous sampling system and described in the field by a geologist or geological engineer. The boring logs are presented in Appendix IV. Also provided in Appendix IV are the logs from seven borings (MW-1 through MW-7) completed during the Expanded Site Inspection (ESI) for PAB Oil and Chemical Services (Ecology and Environment, 1988.)

Three site cross-sections were prepared to illustrate the relationship of the stratigraphic units encountered beneath the site. A cross-section location map, Figure 3.4-1, and the three site cross-sections, Figures 3.4-2, 3.4-3 and 3.4-4, can be found in Appendix I.

The surficial topsoil generally ranged from 0-2 ft below ground surface and consisted of dark brown organic clay with some black fairway-manganese nodules and iron staining. Below the surficial soils is a brown and gray mottled clay. This clay zone extends to depths ranging from 19-23 ft below the ground surface for most of the site. This zone lessens to 13-14 ft below ground surface to the west of the site (MW-11 and MW-12). Black fairway-manganese nodules and iron staining were noted throughout this clay unit. Next, extending to depths of 22-25 ft below ground surface for the majority of the site, was a brown and gray sandy silt and silty clay unit. This zone extends to only 16-17 ft below ground surface to the west of the site. The deepest unit encountered beneath the site, according to the ESI, is a reddish brown to grayish brown sand extending to depths of at least 110 ft below ground surface. This sand unit coarsened downward from fine to medium sized sand to some fine and coarse gravel. Banded iron staining was also reported observed in this zone.

The cross-sections and boring logs reveal, for the most part, three stratigraphic units: an upper clay unit, a middle clay/silt/sand unit and a lower sand/gravel unit. The middle unit appears to act as a transition unit between the upper clay and lower sand. The boring logs and cross-sections also show that where the middle unit was logged, it ranges in thickness from less than 3 ft in MW-5 and MW-9 to near 5 ft in MW-6.

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3.4.3 Soil Geotechnical Properties

The geotechnical properties of the clay unit supporting the disposal pits were investigated by taking four Shelby tube samples. Two samples were taken from the clay unit in each of the MW-10 and MW-11 borings. The samples were analyzed for particle size distribution (hydrometer analysis), cation exchange capacity (CEC), water content, dry density, Atterberg limits and hydraulic conductivity.

The Shelby tube soil samples were delivered to Shannon & Wilson, Inc. of Creve Coeur, Missouri for the geotechnical laboratory testing. Appropriate chain-of-custody procedures were maintained during sample transport and delivery. All laboratory testing was conducted in accordance with specifications set forth by the American Society for Testing and Materials (ASTM). The CEC analyses were subcontracted out by Shannon & Wilson to Environmental Science & Engineering, Inc. A copy of Shannon & Wilson's deliverable is located in Appendix VIII. Table 3.4-A is a summary of the six geotechnical tests. The table also shows the sample depths and ASTM methods utilized. There is no sample MW-10 (ST-2) because when the tube was extracted from 13.0-15.0 ft, there was no recovery.

3.4.3.1 Grain Size Distribution

Samples MW-10 (ST-3) and MW-11 (ST-1) were analyzed for their soil grain properties by a particle size distribution (hydrometer) analysis. This test was performed twice for each sample. The first set of tests were run with a dispersing agent as per ASTM D422-91.

As indicated in the grain size distribution curves in Appendix VIII and from the geotechnical laboratory supervisor, the samples seemed to thicken with time and form a "gel-like" consistency instead of dispersing into individual particles. Therefore, this set of tests was terminated due to the unusual occurrence. The second set of tests was performed without a dispersing agent to prevent the "gel" formation in the hydrometer.

According to the ASTM D653-91 definition for clay size particles, the grain size distribution curves indicate that sample MW-10 (ST-3) contains 75% clay size (<0.005 mm) particles while MW-11 (ST-1) has 68% clay size particles. It must be noted, however, that these results are obtained from a hydrometer analysis in which there was no dispersing agent added to the sample. This lack of a dispersing agent will generally allow the individual particles to flocculate. The hydrometer will then measure the floccules composed of several particles instead of individual particles. This in turn will produce a grain size distribution curve shifted to the left (larger particle size). Therefore, the percentages of clay size particles are probably more than what is indicated in the curves.

TABLE 3.4-A
SUMMARY OF GEOTECHNICAL LABORATORY TEST RESULTS

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Boring No.	Sample No.	Depth	Gradation-- % Finer Than	CEC	Water Content	Dry Density	Atterberg Limits			Hydraulic Conductivity	
		ft	.005 mm	meq/100g	%	lb/ft ³	LL	PL	PI	Avg. K* (cm/sec)	Max. K** (cm/sec)
MW-10	ST-1	8.0 - 10.0		9.8	23	103.7	57	17	40		
	ST-3	15.0 - 17.0	75	18.7	31	--	67	21	46	7.6×10^{-9}	2.8×10^{-8}
MW-11	ST-1	8.0 - 10.0	68	15.0	29	--	76	19	57	2.7×10^{-9}	3.5×10^{-9}
	ST-2	13.0 - 15.0		9.9	15	101.3	36	15	21		
ASTM Method											
			D422	D4319	D2216	D2166	D4318			D5084	

*Average Hydraulic Conductivity was calculated from the last four determinations of the value.

**Maximum Hydraulic Conductivity was the single highest value calculated throughout the duration of the test.

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The grain size distribution curves also show the soil gradation. Sample MW-10 (ST-3) appears to be fairly uniform in gradation while sample MW-11 (ST-1) appears to be fairly well-graded.

3.4.3.2 Cation Exchange Capacity

The surface of a clay particle possesses negative charges. These negative charges are responsible for attracting and accumulating cations (Ba^{2+} , Cu^{2+} , Ca^{2+} , Mg^{2+} , K^{+} , Na^{+}) from the water phase at the clay particle's surface. The total amount of cations adsorbed by the negative charges on a unit mass of soil is defined as the soil's CEC (Dragun, 1988). CEC is usually expressed as milliequivalents (meq) per 100 grams of soil. Table 3.4-B lists CEC ranges for several soil types and clays.

TABLE 3.4-B
General Ranges for The Cation Exchange Capacities of
Several Soil Types and Clays

Soil	CEC (meq/100 grams)
Soil Clays	
Chlorite	10-40
Illite	10-40
Kaolinite	3-15
Montmorillonite	80-150
Oxides and	2-6
Oxyhydroxides	80-120
Saponite	100-150
Vermiculite	> 200
Soil Organic Matter	
Soi Type	2-7
Sand	2-18
Sandy Loam	8-22
Loam	9-27
Silt Loam	4-32
Clay Loam	5-60
Clay	

From: The Soil Chemistry of Hazardous Materials, 1988

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The CEC of all four samples was determined with the values ranging from 9.8 to 18.7 meq/100g. The results are shown in Table 3.4-A. The high percentages of clay size particles in the samples, determined from the hydrometer analysis, verified that the soil unit sampled is a clay. The CEC results, when compared to Table 3.4-B, indicate that the clay is most likely an illite/chlorite clay. Both clay types have an average CEC when compared with other clays but they have an above average CEC when compared to other soil types.

3.4.3.3 Water Content and Dry Density

The water content was determined for all four samples and the dry density was calculated for MW-10 (ST-1) and MW-11 (ST-2) only. The water contents ranged from 18-31% and the dry density values were 101.3 and 103.7 lb/ft³. These results are consistent with published values for the relationship of water content versus dry unit weight for highly plastic (heavy) clays (Spangler and Handy, 1982).

3.4.3.4 Atterberg Limits

Atterberg limits usually refer to the liquid limit and plastic limit. The liquid limit (LL) is the water content at which a soil is at the arbitrarily defined boundary between a liquid and plastic state while the plastic limit (PL) is the water content of a soil when it is at the boundary between the plastic and brittle states (ASTM, 1991). The plasticity index (PI) (the numerical difference between the LL and the PL) is a range of water contents at which a soil exhibits plasticity. The Atterberg limits are used to characterize fine grained soils (silt or clay content, permeability, CEC, and other engineering soil properties).

Three point Atterberg limits were run for each sample. The LL, PL and PI are shown in Table 3.4.-A and the laboratory data sheets are included in Appendix VIII. The liquid limits ranged from 36% in sample MW-11 (ST-2) to 76% in MW-11 (ST-1). The plasticity indexes ranged from 21% to 57% between the same two samples.

The Atterberg limits were used to classify the samples according to the Unified System Classification of Soils (USCS), ASTM D-2487 (ASTM, 1991). Samples MW-10 (ST-1), MW-10 (ST-3) and MW-11 (ST-1) are classified as inorganic clays of high plasticity (CH). Sample MW-11 (ST-2) is classified as an inorganic clay of low to medium plasticity (CL). These Atterberg limits exemplify a clay soil with low permeability (hydraulic conductivity) and a low to medium CEC.

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3.4.3.5 Hydraulic Conductivity

Samples MW-10 (ST-3) and MW-11 (ST-1) were studied to determine their hydraulic conductivity (K). The geotechnical laboratory used one-dimensional flexible wall permeameter to determine the K. The laboratory data sheets are included in Appendix VIII. The average and maximum Ks are summarized in Table 3.4-A.

Sample MW-10 (ST-3), at a depth of 16.1 ft was run for more than 39 days allowing a total of 2.02 pore volumes of water to pass through the sample. The average value of K, taken over the last four readings, was 7.6×10^{-9} cm/sec. The maximum K, 2.8×10^{-8} cm/sec, occurred one day into the test. Sample MW-11 (ST-1), at a depth of 9.6 ft, was run for more than 72 days allowing 1.12 pore volumes of water through the sample. It was decided impractical to allow the test to run until two pore volumes passed through the sample. The average value of K was 2.7×10^{-9} cm/sec. The maximum value of K, 3.5×10^{-9} cm/sec, occurred 26 days into the test.

Both samples produce average and maximum K values that are consistent with published values for unweathered homogenous clay (Peck, et al., 1974).

3.5 HYDROGEOLOGY

3.5.1 Regional Hydrogeology

The major hydrogeologic unit in the site vicinity is the Chicot Aquifer System. The Chicot Aquifer System is subdivided into the Upper and Lower Chicot Aquifers (Nyman, 1990). Locally, the Upper Chicot Aquifer is further divided into the Abbeville Unit and the Upper Sand Unit.

The Chicot Aquifer System generally consists of a coarsening downward sequence of clays, silts, sands, and gravels. The medium-to coarse-grained sand and gravel aquifer units dip and thicken southward toward the Gulf of Mexico. Water levels in the Chicot Aquifer range from near land surface to 150 ft below land surface (Nyman, 1984). Water levels are lowest in areas of heavy industry and significant population.

Water levels in 1903 show a natural southward gradient that probably existed before heavy groundwater development began. Rain falling on areas of recharge for the Chicot Aquifer System, provided baseflow to the Sabine, Vermilion and Atchafalaya Rivers during pre-development years. The southward water level gradients of the early 1900s have been reversed as of approximately 1940 and now slope northward toward large pumping centers (Jones, et al., 1954).

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Figure 3.5-1 depicts the potentiometric surface (Spring, 1981) of the Chicot Aquifer System in southwestern Louisiana. Water levels are higher in the alluvium to the east of Abbeville causing water to move down-gradient to the west into the Chicot aquifer system. There are north-south trending water-level contours east of Abbeville representing this westward flow. The Chicot aquifer system is recharged to the south through vertical leakage. The coastal area wetlands, located approximately ten miles south of Abbeville, provide vertical recharge to the aquifer system (Nyman, 1984). The combination of these two areas of recharge plus the heavy groundwater pumping in the Parishes of Calcasieu, Jefferson Davis and Acadia produce a west-northwest regional groundwater flow across the Abbeville area (Nyman, 1984).

A survey of residential wells in the site vicinity was conducted by reviewing the well construction records that were made available from the Louisiana Department of Transportation and Development and the USGS. Information on local groundwater users was also obtained through interviews with residents in the immediate area. The survey results indicate that residential well depths typically range from 80 - 120 ft below ground surface. The wells are constructed with two to four inch diameter, Schedule 40 PVC casing and slotted PVC screen. Surface mounted, deep well pumps with jets are typically utilized for groundwater pumpage.

An interview conducted by FIT members on May 7, 1986 with Mr. Ralph Avera, City of Abbeville Water Treatment Plant, produced information on three municipal water wells located along the Louisiana State Highway 14 bypass, which draw water from the upper sands of the Chicot aquifer. All three wells are located in Section 47, T12S-R3E, approximately 2.4 miles due south of the site. The three municipal wells range in depth from 229.9-249.5 ft below ground surface. The wells' construction start with a 24 inch black steel surface casing and scope down to a 10-3/4 inch extension casing. The 0.040 gauge, 10 inch diameter, 60 ft long S.S. screens are set at depths ranging from 170-248 ft below ground surface. The pumps in the wells are designed for 1,500 gallons per minute (gpm).

Driller supplied boring logs show that the completion zone for the residential wells is a medium to coarse grain sand. This sand is part of the geohydrologic unit known as the Abbeville Unit (Nyman, 1984.) This unit generally consists of fine to sandy silt at the surface and grades downward within a few tens of feet into sand and gravel. The sand thickness ranges from 100-250 ft (Harder, et. al., 1967).

Estimates on the transmissivity of the Chicot aquifer system range from 10,000 to 135,000 ft² per day, with a storage coefficient ranging from 0.0004 to 0.003 (Nyman, 1990.) The hydraulic conductivity of the Chicot aquifer system was calculated from the

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relationship of the aquifer thickness and transmissivity to be in the range of 40 to 1,300 ft per day (1.4×10^{-2} to 4.6×10^{-1} cm/sec). Well records indicate that large diameter irrigation wells in the area have yields up to 2,500 gpm.

3.5.2 Site Hydrogeology

The hydrogeologic regime of the site was studied by drilling and installing five (5) monitoring wells, coupled with observations from the existing seven wells. The elevations and completion intervals for the monitoring wells are presented in Table 3.5-A. All 12 monitoring wells are screened in the sand and gravel unit that underlies the site. Monitoring wells MW-2 through MW-12 are completed with the screened interval intersecting the piezometric surface. This design allows for seasonal fluctuations of the groundwater and the detection of any light non-aqueous phase liquids (LNAPLs) that might be present. The total depths of the wells ranged from 35-42.8 ft below ground surface. Monitoring well MW-1, however, was completed as a deep well, and is screened at a depth of 105-115 ft with a total depth of 121.5 ft below ground surface.

3.5.2.1 Observations

Six rounds of groundwater level readings are presented in Table 3.5-B. The table shows the groundwater elevations for each monitoring well along with the dates each reading was observed. Five of the six rounds of readings were completed on five separate days. The sixth round, column number three on Table 3.5-B, was taken over a period of three days during a sampling effort. The complete set of groundwater level readings encompass nearly a full calendar year with the first reading collected on March 22, 1991 and the last reading collected on February 4, 1992.

The reading taken on October 29, 1991 for MW-7 is believed to be invalid. The field calculated elevation of -9.99 feet, mean sea level (MSL), appears to be in error of approximately 0.2 ft. The reading taken on the day before, October 28, shows the groundwater level for MW-7 to be -9.81 ft MSL. The difference between the two consecutive readings, 0.18 ft, is not consistent with the differences between the remaining eleven wells (refer to Table 3.5-B, columns four and five). It was also found, during the December 4, 1991 readings, that the dedicated bailer in MW-7 was suspended in the water column. This finding indicates that the bailer could have been in the water column during the previous reading on October 29. It is known that the bailer was not suspended in the water prior to the reading taken on October 28. Therefore, the combination of the bailer being suspended in the water column prior to the measurement on October 29 and the water level reading being taken before the water column could regain its equilibrium state would account for the apparently erroneous low reading. The

TABLE 3.5-A
MONITORING WELL ELEVATIONS
UNITS: FEET

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Well No.	Screen Interval Elevation (FT MSL)	Ground Elevation (FT MSL)	TOC Elevation* (FT MSL)
MW-1	-86.1 to -96.1	18.9	21.55
MW-2	-6.0 to -16.0	18.9	21.33
MW-3	-4.7 to -14.7	20.0	22.48
MW-4	-4.4 to -14.4	20.6	23.18
MW-5	-6.8 to -16.8	17.7	20.05
MW-6	-7.9 to -17.9	16.8	19.27
MW-7	-6.9 to -16.9	18.1	20.45
MW-8	-8.3 to -22.8	19.5	21.86
MW-9	-5.9 to -20.4	21.9	24.55
MW-10	-5.2 to -20.2	18.4	21.36
MW-11	-5.8 to -20.8	16.9	20.01
MW-12	-6.1 to -21.1	16.9	19.78

*Top of Casing Elevation

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well was allowed to regain its equilibrium before the reading was taken on December 4, 1991. To account for this believed error, the MW-7 groundwater level reading of -9.81 ft MSL from October 28, 1991 should be utilized instead of -9.99 ft MSL from October 29, 1991.

The seasons of the year and any infiltration, resulting from recent rainfalls (discussed in Section 3.2) do not appear to have any significant affects on the groundwater levels. Table 3.5-B illustrates that the lowest groundwater levels were collected on March 22, 1991 and the highest groundwater levels were collected on February 4, 1992. The groundwater levels in monitoring wells MW-2 through 9 ranged from -10.52 ft MSL in the west to -10.31 ft MSL in the east on March 22, 1991 (early spring) and from -9.26 ft MSL in the west to -9.05 ft MSL in the east on February 4, 1992 (late winter).

The readings from October 29, 1991 (late fall) and December 4, 1991 (early winter) are very similar differing by only a few hundredths of a foot. The August 20, 1991 (late summer) reading shows a lower groundwater level, as expected, but still not as low as the spring readings collected on March 22, 1991.

Single well slug and recovery tests, to study the hydraulic conductivity of the sand hydrogeologic unit under the site, were conducted at two site monitoring wells during Phase 1. The test data was analyzed by two analytical methods, Bouwer and Rice (1976) and Thompson (1987). The data, assumptions of the analytical methods, and results are presented in Appendix VI. The calculated hydraulic conductivity ranged from 3×10^{-3} to 2×10^{-2} cm/sec. This range is consistent with published values for silty to clean sands (Freeze and Cherry, 1979).

In Phase 2, a geotechnical laboratory conducted hydraulic conductivity tests on two samples taken from the clay unit under the site. Details of the tests are discussed in Section 3.4.3.5. The laboratory report can be found in Appendix VIII. The laboratory reported average hydraulic conductivities of 2.7×10^{-9} cm/sec and 7.6×10^{-9} cm/sec for the two samples. These values are consistent with published values for unweathered marine clay (Freeze and Cherry, 1979).

Representative groundwater flow conditions under the site are illustrated in Figures 3.5-2 and 3.5-3. Figure 3.5-2 represents the conditions during the Phase 1 field investigation on March 22, 1991. Figure 3.5-3 represents the conditions during the Phase 2 field investigation on October 29, 1991.

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TABLE 3.5-B
GROUNDWATER LEVEL ELEVATIONS
UNITS: FEET (MSL)

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Date Measured	03/22/91	08/20/91	10/27-29/91	10/29/91	12/04/91	02/04/92
Well No.						
MW-1	-10.07	-9.51	-9.45 (10/29)	-9.38	-9.36	-8.77
MW-2	-10.38	9.81	-9.76 (10/29)	-9.71	-9.68	-9.10
MW-3	-10.32	-9.76	-9.72 (10/29)	-9.66	-9.64	-9.08
MW-4	-10.32	-9.77	-9.63 (10/28)	-9.65	-9.63	-9.05
MW-5	-10.51	-9.95	-9.84 (10/28)	-9.84	-9.81	-9.26
MW-6	-10.52	-9.99	-9.85 (10/28)	-9.85	-9.85	-9.23
MW-7	-10.47	-9.89	-9.81 (10/28)	-9.99*	-9.79	-9.21
MW-8	-10.34	-9.79	-9.70 (10/28)	-9.68	-9.65	-9.08
MW-9	-10.31	-9.76	-9.64 (10/28)	-9.64	-9.62	-9.07
MW-10	--	--	-9.57 (10/27)	-9.64	-9.67	-8.99
MW-11	--	--	-9.86 (10/27)	-9.88	-9.86	-9.34
MW-12	--	--	-9.99 (10/27)	-10.02	-9.98	-9.36

*The field reading is believed to be in error. In place of the errant -9.99 feet, use the reading from 28 October 1991 of -9.81 feet.

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Both groundwater elevation contour maps show the groundwater flow direction to be generally west-northwest. The calculated gradient across the site, based on monitoring wells which intersect the groundwater surface, is approximately 0.0002 ft/ft, which is reflective of the relatively flat topography. The illustrated groundwater flow directions and gradients are typical of the regional conditions which were discussed in Section 3.5.1.

An upward (vertical) hydraulic gradient in the sand unit is suggested by the difference in water levels at MW-1 and MW-2. MW-1, screened at a depth of 105-115 ft has a higher potentiometric level than MW-2 which is screened at a depth of 24.9-34.9 ft below ground surface. The deeper well, MW-1, tends to have on average a higher potentiometric head by approximately 0.32 ft.

There are a couple of anomalies in the groundwater data which can be seen in the two contour maps. There is a reduction in gradient between MW-5 and MW-6, shown on Figures 3.5-2 and 3.5-3, and between MW-10 and MW-9, shown in Figure 3.5-3. Attempts were made to contour the groundwater data to better represent these anomalies. Based on the limited information available, it was decided that the additional attempts did not have adequate supporting data to justify their representation. Therefore, the original depictions of the groundwater flow under the site, Figures 3.5-2 and 3.5-3, are still believed to be the most representative of the site conditions.

It does not appear that the ponds and disposal pits are having a significant influence on the direction of groundwater flow. The groundwater flow direction and gradient depicted in Figures 3.5-2 and 3.5-3 are consistent with the regional characteristics. The low hydraulic conductivity values produced from the clay unit, which separate the ponds and pits from the aquifer, indicate that only a very small amount of flow could be passing through the clay. The apparent consistency of the site groundwater flow with that of regional flow coupled with the low conductivity of the clay unit, provides support that the flow under the site is not being significantly impacted by the ponds or disposal pits.

3.5.2.2 Irrigation Well Influence

During the site study, it was found that there are two irrigation wells in the immediate vicinity of the site. The closer of the two wells was studied to determine if the well pumpage had an effect on the groundwater flow pattern across the site. Although there is not sufficient data and information to conduct a detailed analytical study, a qualitative comparison was made.

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The owner/operator of the irrigation well stated that the well operated at 2,500 gpm at five or six different periods from March through early August. The owner/operator also stated that the well did not operate prior to March or after August of 1991 and that a typical pumping period consisted of pumping the well for three or four days before allowing it to sit idle for two weeks.

In theory, if monitoring well "A" is closer to a pumping well than monitoring well "B", well "A" will have a greater drawdown resulting from the pumping well than will well "B". This principle was applied to the site by comparing the differences in groundwater elevations between the monitoring wells closer to the irrigation well and the monitoring wells further away. There were no noticeably significant differences in the water levels between the close and distant wells when compared during the time of pumping (March 22, 1991) and during the times of non-pumping (all groundwater level readings except March 22, 1991). From this study and the limited information available, there is no substantial evidence showing that the irrigation wells have an affect on the groundwater flow pattern across the site.

3.5.2.3 Diurnal Effects

Local effects on the potentiometric surface from diurnal effects such as tides and atmospheric pressure changes were studied for an eight-hour period on March 22, 1991. A complete round of water levels, along with a barometric pressure reading, were measured three times during the eight-hour period. The data is presented in Table 3.5-C.

The Barometric pressure decreased slightly during the morning period, from approximately 29.96 to 29.90 inches Hg. During that same period, the water levels at site wells did not fluctuate significantly. Very little fluctuation in either the water levels or barometric pressure was noted during the afternoon period. This data indicates that diurnal effects on the potentiometric surface from tidal influences was minimal during the eight hour time period since a noticeable impact to the water levels was not observed.

TABLE 3.5-C
DIURNAL EFFECTS ON
GROUNDWATER LEVEL ELEVATIONS
FOR MARCH 22, 1991

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Well No.	Time	Barometric Pressure (In Hg)	Groundwater Level Elevation (Ft. MSL)	Time	Barometric Pressure (In Hg)	Groundwater Level Elevation (Ft. MSL)	Time	Barometric Pressure (In Hg)	Groundwater Level Elevation (Ft. MSL)
MW-1	0741	29.96	-10.07	1136	29.90	-10.07	1550	29.91	-10.05
MW-2	0745	29.95	-10.38	1134	29.90	-10.38	1547	29.91	-10.37
MW-3	0800	29.95	-10.32	1148	29.90	-10.32	1600	29.90	-10.28
MW-4	0754	29.95	-10.32	1142	29.90	-10.32	1555	29.90	-10.30
MW-5	0737	29.96	-10.51	1130	29.90	-10.52	1543	29.92	-10.51
MW-6	0728	29.96	-10.52	1126	29.93	-10.54	1539	29.91	-10.51
MW-7	0724	29.96	-10.47	1122	29.94	-10.48	1533	29.91	-10.46
MW-8	0749	29.95	-10.34	1140	29.90	-10.35	1552	29.90	-10.33
MW-9	0756	29.95	-10.31	1145	29.90	-10.32	1556	29.90	-10.29

Section IV

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4.0 NATURE OF CONTAMINATION

Phase I Remedial Investigation field activities at the PAB Oil and Chemical services, Inc. Superfund Site were conducted from January 14 - March 29, 1991. The field activities for Phase 2 were conducted from October 7 - October 31, 1991. Section 2.0 and 3.0 describe the remedial investigation activities conducted at the site and present data on the physical and areal characteristics of the site and surrounding area. This section will present an evaluation of chemical and field investigation data obtained during the site characterization which includes:

- Chemical analysis of all contaminant sources identified;
- Chemical analysis of off-site and on-site soil samples;
- Chemical analysis of groundwater samples;
- Field parameter measurements of surface water and groundwater samples (temperature, conductivity and pH);
- Chemical Analysis of site drainage areas.

The analytical data has been summarized into tabular form and is included in Appendix II. These summarized tables only include the parameters that were detected. A complete list of those parameters analyzed for is included as Table 4.0-1 and 4.0-2 in Appendix II.

Analytical test results were reviewed and evaluated in accordance with the CLP as administered by EPA. Under the CLP, a system has been developed to evaluate the quality of inorganic and organic lab data. Qualified data is coded with a qualifier letter, as necessary. (not meeting spike recoveries), etc. A list of qualifier codes is included as Table 4.0-3 in Appendix II.

Some data required a qualifier code of "J", which indicates an estimated value. Estimation may have been necessary for a variety of reasons:

- the sample holding time may have been exceeded,
- the lab may have experienced interference difficulties,
- the linear range of the detecting instrument may have been exceeded,
- there may have been instrument calibration problems,
- lab blanks may have been contaminated, or
- lab duplicate sample results, matrix spike recoveries, or lab control sample results may have been outside designated control limits.

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While many data results are coded as "J", the data was properly evaluated and considered useable for risk assessment purposes. This is further discussed in the baseline risk assessment documents (LSI, 1992a and 1992b).

An "R" qualifier code has been used in cases where the data is considered unusable due to a laboratory problem more serious than those described for estimated values.

During review of the undetected, or "U" qualified data, some of the detection limits reported may appear to be high. The specific quantitation limits are highly matrix dependent and some of the media samples from the PAB site, such as the pit sludges, have very complex matrices. This acts to complicate the analysis because there are so many compounds present that interferences may mask the signal of the particular analyte of interest. An attempt to remove interferences was conducted by performing clean-up procedures. Problems were encountered due to the likelihood of removing an analyte of interest compound along with the interfering compound because of the similar molecular structure. Additionally, various samples were diluted by the laboratory prior to analysis in order to reduce the high concentrations detected. Dilutions were corrected for, however, quantitation limits for undetected parameters are similarly affected.

Care should be utilized when reviewing the tables in that data is presented in both $\mu\text{g}/\text{kg}$, mg/kg , $\mu\text{g}/\text{l}$ and ng/l depending on the media sampled, the concentration detection and the parameter analyzed for.

4.1 BACKGROUND SOIL

Six (6) off-site locations were selected to obtain background soil samples. The first four locations (shown in Figure 2.1-1) were sampled during the Phase 1 field investigation. Depth discrete samples were obtained from each location at depths of: 0-0.5 ft, 1-1.5 ft and 2.5-3 ft. Samples were analyzed for TCL organic and TAL inorganic parameters, including cyanide, chloride, TPH and pH. The last two locations, which were soil borings converted into monitoring wells MW-10 and MW-12, were sampled during the Phase 2 investigation and are shown in Figure 2.4-1. Five depth intervals were sampled from each location. MW-10 was sampled at depths of: 0-1 ft, 2-3 ft, 5-6.5 ft, 10-11 ft and 17-18 ft. MW-12 was sampled from: 0-1 ft, 2-3 ft, 9-10 ft, 14-15 ft and 16.4-17.4 ft. The Phase 2 samples were analyzed for TCL organic and TAL inorganic parameters, chloride and TPH.

In reviewing the organic contaminants detected in the background soils, it is assumed that no target organic compounds exist naturally in the soils. However, certain target organic compounds and TICs were detected at very low concentrations in some of the

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background soils. Because of the sporadic nature of these contaminants and the low observed concentrations, it is difficult to determine if these constituents are present as a result of the agricultural use of the land surrounding the site, sample handling or laboratory contamination. Because soils are comprised of naturally occurring metals, the inorganic background concentrations were studied and used as a general guideline for comparison with on-site samples.

4.1.1 Background Soil - Organics

The volatile organic compounds detected in the background soils are included in Tables 4.1-1, 4.4-1 and 4.4-2. Methylene chloride and acetone were detected in most of the samples as well as the laboratory blanks and are considered attributable to laboratory impact. Carbon disulfide and tetrachloroethene were the only other volatile organics detected. Carbon disulfide was detected in the 2.5-3 ft soil sample collected from the north background location. Tetrachloroethene was detected in the 0-1 ft sample collected at MW-12. The levels reported are estimated in both cases since the values are less than the laboratory contract required detection limits (CRDLs). There was only one volatile tentatively identified compound (TIC) detected in the background soils. A blank contaminant TIC was detected in the 2-3 ft sample of MW-12 at a concentration of 10BJ $\mu\text{g}/\text{kg}$.

The semivolatile analysis (Tables 4.1-2, 4.4-3 and 4.4-4) revealed five phthalate esters which are common as laboratory contaminants as well as being common in urban area soils. The only other TCL semivolatiles detected were 4-methylphenol, at 160J $\mu\text{g}/\text{kg}$ in the 0-0.5 ft north background sample and benzoic acid. Benzoic acid was detected in at least one sample from each Phase 1 background location up to 5,500 $\mu\text{g}/\text{kg}$ in the 2.5-3 ft east background sample. 4-methylphenol was undetected in all other background samples although the reported detection levels were higher than 160 $\mu\text{g}/\text{kg}$. Benzoic acid was not detected at either of the Phase 2 background locations, MW-10 and MW-12.

Unknown semivolatile organic TICs were also detected in the background soil samples at levels up to 8,800AJ $\mu\text{g}/\text{kg}$ (Tables 4.1-3, 4.1-4 and 4.4-6 through 4.4-8). The greatest number of TICs (28) occur in the surface sample at MW-10. Within the depth-discrete samples taken at each of the six background locations, the greatest number of TICs occur at or near the surface. As discussed in Section 2.1, all of the fields surrounding the site are used for grazing/agricultural purposes. Residual fertilizers and/or pesticides may be attributing to the large number of semivolatile organic TICs.

The soil samples were also analyzed for TPH, however, the Phase 1 data has been determined to be unusable due to low matrix spike recovery and is not reported. The

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Phase 2 data is presented on Tables 4.4-3 and 4.4-4. All of the TPH values from MW-12 are reported as undetected (<31 mg/kg). TPH was detected greater than 30 mg/kg in all but one of the six samples from MW-10. The detected values ranged from 38.0 mg/kg in the 10-11 ft sample to 71.7 mg/kg in the 17-18 ft sample.

No detectable levels of TCL pesticides or PCBs were found in any of the Phase 1 background soil samples. Five pesticides were detected at trace amounts in the Phase 2 background soil samples (Tables 4.4-9 and 4.4-10). Four compounds were detected in the surface sample of MW-10 and two compounds detected in the surface sample of MW-12. With the exception of $0.161 \mu\text{g/kg}$ of gamma-chlordane detected in the 17-18 ft sample of MW-10, there were only two other samples with a detected pesticide -- the 2-3 ft sample in both MW-10 and MW-12. All the values are estimated due to the low level detected, the detection of the compound in the associated lab blank or a difficulty in quantifying the result.

The presence of pesticides is possible due to the local land use practices of grazing and agriculture. Although it was not witnessed on the immediately adjacent fields which contain the background sample locations, aerial crop dusting was noticed in the site vicinity during the field investigations. Some of the detected pesticides can possibly be attributed to residual pesticide dust resulting from discharges during past overhead flybys and windblown particulate.

4.1.2 Background Soil - Inorganics

The inorganic sample results for the background soil samples are reported in Tables 4.1-5, 4.1-6, 4.4-12, 4.4-13 and 4.4-14. Because soils are comprised of naturally occurring metals, a summary table, Table 4.1-A (included with text) was created so that the background metal concentrations could be used as a guideline for comparison with other on-site soils.

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TABLE 4.1-A
RANGE OF BACKGROUND SOIL CONCENTRATIONS
TOTAL METALS ANALYSIS
UNITS: mg/kg

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Metal	Off-site Background				Typical Background ¹	
	0-1'	1'-3'	5'-10' ²	10'+	West	East
Aluminum	4,990-11,800J	7,700J-31,400J	8,450-13,700	6,550-13,700	58,000	33,000
Antimony	7.8UJ-14.0UJ	8.6UJ-11.5UJ	8.6UJ ³	8.8UJ-9.3UJ	0.47	0.52
Arsenic	1.7B-7.3	1.8B-14.1	1.2J-2.6J	2.7J-3.5J	5.5	4.8
Barium	115J-152	88.3-256	151J-156	88.3-190	580	290
Beryllium	0.45U-0.95B	0.49U-1.5	0.49U-1.1B	0.43B-1.2B	0.68	0.55
Cadmium	0.89U-2.1U	0.97U-1.7U	0.48U-0.98U	0.46U-1.1U	1	1
Calcium	731J-2,720	669B-2,180	2,030-3,020	1,630-5,130	—	—
Chromium	6.8-17.9	11.5U-31.8	11.4-15.7	7.9-17.6	41	33
Cobalt	3.2B-6.1B	2.1B-9.8B	2.2U-4.2B	4.5B-33.1	7.1	5.9
Copper	7.8-10.3	9.0U-35.4	9.1-15.6	7.3-21.3	21	13
Iron	4,340-20,600J	6,790-39,800	10,100-16,400	9,190-18,800	21,000	14,000
Lead	10.9J-17.3	7.6-33.3	5.6J-8.9	8.4-19.1J	17	14
Magnesium	456B-867B	533B-2,450	1,750-2,640	1,850-4,240	—	—
Manganese	254J-641J	62.9J-772J	27.3-93.7	172-590	380	260
Mercury	0.09U-0.15	0.10U-0.14U	0.11U-0.12U	0.11U-0.13U	0.046	0.081
Nickel	4.4U-8.6B	5.3B-22.2	9.9-15.4	12.1-25.3	15	11
Potassium	133B-667B	330B-1,420	436B-738B	697B-1,610	—	—
Selenium	0.23U-0.68UJ	0.25UJ-0.56UJ	0.48UJ-0.49UJ	0.46UJ-0.50U	0.23	0.30
Silver	0.89UJ-2.0U	0.98U-1.7U	0.98UJ-1.4B	0.92U-2.0B	—	—
Sodium	80.1B-151J	245B-293J	349B-413B	173B-424B	—	—
Thallium	0.25UJ-0.79B	0.24U-1.1B	0.49U-1.2	0.50U-1.3U	9.1	7.7
Vanadium	13.0B-32.4	14.0-58.1	14.7-17.2	11.8B-24.9	70	43
Zinc	18.5-27.7	19.2-54.4	20.5-35.0	25.9-55.0	55	40
Cyanide	0.63UJ-0.85UJ	0.61UJ-0.70UJ	—	—	—	—

¹Values obtained from "Element Concentrations of Soils and Other Surface Materials of the Conterminous United States" dated 1984, USGS Professional Paper 1270, East/West division is made at the 96W longitudinal line. Transferred from Table A in Appendix III.

²The duplicate of the 5-6.5 ft sample from MW-10 is believed to be an extraneous outlier and it is not utilized in the range of values.

³Only one useable data result.

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All of the depth-discrete background soil samples were subdivided into four sample depth interval categories; 0-1 ft, 1-3 ft, 5-10 ft and 10+ ft. In this manner, assessments can be made comparing the upper soil column against the lower. The range shown for any given analyte on Table 4.1-A is produced from the minimum and maximum values detected in all of the background samples which fall into one of the depth categories. Including duplicate samples, the 0-1 ft category was compiled from seven samples, the 1-3 ft category was compiled from ten samples, the 5-10 ft category was compiled from three samples and the 10+ ft category was compiled from four samples. The duplicate 5-6.5 ft sample for MW-10, shown on Table 4.4-12, was not taken into consideration for the compiled 5-10 ft category. This sample appears to be an extraneous outlier. The duplicate produced some values that are three orders of magnitude greater than the sample for which it is supposed to duplicate. Because of the high values, this sample was not considered representative of the background conditions, therefore, it was not included in Table 4.1-A.

Chloride, total solids and pH values were also analyzed and reported on Tables 4.1-5, 4.1-6 and 4.4-12 through 4.4-14. There are no significant differences among the locations in any of the performed analysis to indicate that the results are not representative of background soil conditions and that there has been any artificial impact. Several of the elements, such as calcium and magnesium increase in concentration with depth. This is attributed to the difference in soil matrix, mainly clay, between the lower samples compared to the upper top soil samples. There are also no significant deviations between the off-site values and the typical background values shown in Table 4.1-A.

The values discussed in this section and the generated background soil concentration range table, Table 4.1-A, are utilized throughout the remainder of the report for comparison purposes to study possible impacts to the environment caused by site activities.

4.2 SURFACE WATER AND SEDIMENT INVESTIGATIONS

The site surface water and sediment investigation addressed three main areas/topics of concern; the site drainage/runoff, the southeast marsh area and the abandoned canal. To aid in the presentation and understanding of the results, the site drainage/runoff area of concern was further divided up into three sub-areas; the Route 167 ditches, the site access road ditches and the southeast and southwest corners.

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4.2.1 Site Drainage/Runoff

The majority of surface runoff from the site, including overflow from the saltwater ponds, drains to the west, in the ditches on both sides of the site access road. Flow continues along the road to the drainage ditch on the east side of Louisiana Route 167. Flow then drains to the north.

4.2.1.1 Route 167 Ditches

Sediment and surface water samples were collected from the ditches that run adjacent to Route 167, near the western boundary of the site, to evaluate any impacts that may have occurred from contaminants being carried off-site by surface runoff. Sample locations are shown on Figure 2.2-1.

As indicated, during the Phase 1 investigation, three locations were sampled from the ditch on the east side of Route 167. These locations were identified as the north, middle and south locations. During Phase 2, three upgradient locations were sampled to identify "background" concentrations. These locations consisted of the ditch on the west side of Route 167, a location further north of the site in the east ditch and the south location which was also previously sampled in Phase 1.

It should be noted that in 1985, LA Route 167 underwent an expansion to a four-lane divided highway. This construction would have impacted any residual contamination resulting from discharges that had occurred during the operation of the PAB Oil facility. The sampling during the RI was performed to provide an indication of any contamination that may possibly remain and if contamination is currently being carried off-site and/or deposited by surface runoff.

4.2.1.1.1 Route 167 Ditch Sediment Samples

The Route 167 site drainage/runoff sediment samples were collected from the 0-1 ft depth during Phase 1 and from 0-0.5 ft during Phase 2. The samples were analyzed for TCL organics, TAL inorganics, chloride and TPH. Phase 1 samples were additionally analyzed for cyanide and soil pH.

4.2.1.1.1.1 Route 167 Ditch Sediment Samples - Organics

The organic compounds detected in the Route 167 site drainage/runoff sediment samples are included in Tables 4.2-1, 4.2-2 and 4.2-3. The only volatile organics detected were methylene chloride and acetone which were also detected in many of the associated

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laboratory blanks. The only semivolatile identified was bis (2-ethylhexyl) phthalate, which was found in samples both upstream and downstream from the site. This compound was also found in several of the associated laboratory blanks. Phthalates are common laboratory contaminants and they are also commonly detected in urban area soils. As reported in Section 4.1, phthalates were detected in the background soil samples also. The highest value of bis (2-ethylhexyl) phthalate reported was 500J $\mu\text{g}/\text{kg}$ in the middle Route 167 ditch sample (Figure 2.2-1).

Various semivolatile TICs were detected in the Route 167 sediment samples also (Table 4.2-2). The majority of the TICs were not reported as a specific compound but are labeled unknown. Tetrachloroethane was identified in the four upstream/background samples collected during the Phase 2 investigation, with the highest value being 390J $\mu\text{g}/\text{kg}$ in one of the samples collected from the west ditch along Route 167. This volatile compound however was not identified in the volatile analysis for any of the samples. Instead, detection limits of 12-15 $\mu\text{g}/\text{kg}$ were reported. Endrine ketone was reported as a TIC for the north Route 167 sample at 590J $\mu\text{g}/\text{kg}$. This TCL compound was not identified in the pesticide analysis. Instead, a detection limit of 21 $\mu\text{g}/\text{kg}$ was reported. The tentative identification of these compounds is therefore suspect. Comparatively the upstream/background samples collected during Phase 2 had a greater number of detected TICs than the downstream samples collected during Phase 1.

No detectable levels of TCL pesticides or PCBs were found in any of the sediment samples collected during Phase 1 (Table 4.2-3). Low levels of four pesticides; beta-BHC, heptachlor epoxide, dieldrin and endosulfan II, were detected in the Phase 2 samples. All the values are qualified as having also been found in the associated lab blanks or that the quantitation of the sample results did not meet required limits and are therefore considered estimated.

The TPH results for Phase 1 samples were determined to be unusable due to low matrix spike recovery and are not reported. The TPH data for Phase 2 (Table 4.2-1) indicates a low detectable level in all of the samples, the highest being 45 mg/kg in the northern location along the east Route 167 ditch.

4.2.1.1.1.2 Route 167 Ditch Sediment Samples - Inorganics

The inorganic results for the Route 167 site drainage/runoff sediment samples are reported in Table 4.2-4. Chloride, total solids and pH are also reported. When compared to levels found in the background soil samples and the upstream/background ditch samples, no significant elevated levels were identified in the Route 167 ditch sediments. Levels were actually slightly higher for many of the elements in the southern,

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upstream samples and the samples collected on the west side of Route 167. Mercury was detected at 0.3 mg/kg in the southern sample but was undetected at lower concentrations in the downstream samples. The second southern ditch sample collected during Phase 2 had a undetected mercury level of 0.09U mg/kg.

Arsenic levels detected in the background ditch sediment samples were also higher than those found downstream of the site or those detected in background soil samples as reported in Section 4.1.

4.2.1.1.2 *Route 167 Ditch Water Samples*

Surface water samples collected from the Route 167 ditches during the RI were analyzed for TCL organics, TAL inorganics, chloride and TOC. Phase 1 samples were additionally analyzed for COD and cyanide and Phase 2 samples were additionally analyzed for TPH.

4.2.1.1.2.1 Route 167 Ditch Water Samples - Organics

The volatile compounds detected in the Route 167 site drainage/runoff surface water samples are included in Table 4.2-5. Methylene chloride and acetone were the only compounds detected. These compounds were also identified in the laboratory blanks and are therefore considered attributable to laboratory influence. As indicated in the data table, the bottles for the south Route 167 ditch sample from Phase 1 broke in shipment to the laboratory, therefore, volatile data are not available for this upstream location during that event. This location was resampled during Phase 2.

The only detectable TCL semivolatiles identified were in the background surface water sample collected on the west side of Route 167 (Table 4.2-5). Di-n-butylphthalate, 1J $\mu\text{g/l}$ and bis (2-ethylhexyl) phthalate, 2BJ $\mu\text{g/l}$, were the highest levels detected.

Numerous low level semivolatile TICs were identified in the northern background surface water sample collected on the east side of Route 167, while only one TIC was detected for each of the downstream samples (Table 4.2-6).

The only pesticides detected were reported in the background/upstream Route 167 surface water samples (Table 4.2-7) at very low concentrations. All the values are considered estimated due to the extremely low levels reported, and for many of the samples, the quantitation of the sample result did not meet required limits.

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TPH, TOC and COD values, reported on Table 4.2-5, provide no indication of organic impacts to the surface water originating from the site. The detectable levels are not unusual. Elevated values are expected in surface water which contains runoff from road surfaces and from agricultural fields.

4.2.1.1.2.2 Route 167 Ditch Water Samples - Inorganics

The inorganic sample results from the Route 167 site drainage/runoff surface water samples are reported in Table 4.2-8. Chloride, temperature, conductivity and pH are also reported. The Phase 1 data indicated a possible trend in the surface water data for barium, in that levels increase in the samples located closer to the site. The "north" Route 167 ditch sample had 268 $\mu\text{g/l}$ barium compared to 101B $\mu\text{g/l}$ and 98.2B $\mu\text{g/l}$ barium in the middle and south Route 167 ditch samples, respectively. Barium levels detected in background waters during Phase 2, however, were even higher at 475 $\mu\text{g/l}$ measured on the west side of Route 167.

The highest lead concentration, 11.0J $\mu\text{g/l}$, was also measured in the north Phase 1 sample of surface water originating from the site. The only arsenic detected occurred in the Phase 2 samples collected from background locations. The highest being 14.6J $\mu\text{g/l}$, measured from the north upstream ditch on the east side of Route 167.

The Phase 1 data also revealed other inorganics showing a possible impact from site surface runoff. Calcium, sodium and chloride levels increase in the "north" sample, downstream of the confluence of the site access road ditches, which carry runoff from the majority of the site. The values reported are 15,400 $\mu\text{g/l}$ calcium, 38,100 $\mu\text{g/l}$ sodium and 55J mg/l chloride. Sodium and calcium levels on the west side of Route 167, away from any site influence, were much higher. Calcium was measured at 47,600 $\mu\text{g/l}$ and sodium was 181,000 $\mu\text{g/l}$.

4.2.1.2 Site Access Road Ditches

Sediment and surface water samples were collected from the drainage ditches that occur on both sides of the site access road. The majority of sampling was conducted from the ditch south of the road because the majority of surface runoff, including that from the disposal pits, the saltwater ponds and the storage tank area, exits the site through this ditch. Sample locations are shown on Figures 2.2-2 and 2.2-3.

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4.2.1.2.1 *Site Access Road Ditch Sediment Samples*

Site drainage/runoff access road ditch sediment samples were analyzed for TCL organics, TAL inorganics, chloride and TPH. Phase 1 samples were additionally analyzed for cyanide, TCL pesticides and PCBs and soil pH. Three of the five sediment samples collected during Phase 2 were also analyzed for dioxins and furans. This was done to study the extent of contamination in the event detectable levels were found during the analysis of pit sludge or pond sediments. Pesticides/PCBs were not requested during Phase 2 since detectable levels were not found during Phase 1. Two of the samples did, however, receive pesticide/PCB analysis by the laboratory, therefore, the results are included in the data tables.

4.2.1.2.1.1 Site Access Road Ditch Sediment Samples - Organics

The volatile compounds detected in the site access road ditch sediments are included in Tables 4.2-9 and 4.2-14. Methylene chloride and acetone were the only compounds detected. These compounds were also detected in the laboratory blanks. One volatile TIC at 18J $\mu\text{g/kg}$ was identified as an unknown hydrocarbon in the Phase 2 sample collected at the property line from the south ditch. No other TICs were identified in any of the remaining samples.

The only TCL semivolatiles detected (Tables 4.2-9 and 4.2-14) were benzoic acid at 64J $\mu\text{g/kg}$ in the north site road ditch and bis (2-ethylhexyl) phthalate in both the north and south ditches. The highest phthalate was 490BJ $\mu\text{g/kg}$ in the ditch leading from the large pond to the access road ditch. Bis (2-ethylhexyl) phthalate was also detected in the lab blanks for the majority of samples.

Various semivolatile TICs were also detected in the site access road ditch sediment samples (Tables 4.2-10 and 4.2-15). The majority of the TICs were not reported as specific compounds but were labeled as unknowns or unknown hydrocarbons. Tetrachloroethane was identified in two of the ditch samples collected during Phase 2, with the highest value reported at 440J $\mu\text{g/kg}$. This volatile compound, however, was not identified in the volatile analysis. Diethylbenzene was identified at 460J $\mu\text{g/kg}$ in the ditch leading from the pond. This compound was not identified in a corresponding duplicate sample. Compared to background soil levels and Route 167 ditch sediments, there is a greater number of TICs, with a greater concentration in the south access road ditch.

The TPH results for Phase 1 access road ditch sediment samples were determined to be unusable due to low matrix spike recovery and are not reported. The TPH data for

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Phase 2 (Table 4.2-9) indicated low detectable levels in three of the five samples, the highest being 60.0 mg/kg, which occurred at the site boundary.

As indicated previously, pesticides and PCBs were not detected during Phase 1, therefore additional analysis was not requested. However, two of the sediment samples, those from the ditch leading away from the pond, were analyzed. Their results are included in Table 4.2-11. Four pesticides, dieldrin, 4,4'-DDE, endrin and 4,4'-DDT, were detected at levels below the normal reported detection limit. Endrin was also detected in the laboratory's blank sample and 4,4'-DDE and 4,4'-DDT are qualified due to the fact that the quantitation of the sample results did not meet required limits.

Results of the dioxin and furan analysis are presented in Table 4.2-12. Often dioxin and furan isomers are referred to in their abbreviated forms such as X,X,2,3,7,8-hexachlorinated dibenzo-p-dioxin. This notation implies that a chlorine atom is positioned on the dioxin molecule carbons corresponding to the numbered positions of 2,3,7 and 8. The "X,X" signifies that two other chlorine atoms are located on the molecule at any two of the remaining positions: 1,4,6 or 9. Since the positions other than 2,3,7 or 8, are not associated with toxicity of the dioxin molecule, they are usually abbreviated. These abbreviated forms were utilized on the dioxin and furan data summary tables.

The most toxic dioxin isomer is 2,3,7,8-TCDD (tetrachlorodibenzo-p-dioxin) (Mocarelli, et. al, 1991). Yet, other dioxins and furans, which are chlorinated in the 2,3,7, and 8 positions on the molecule, exhibit toxicity but to a lesser degree. Procedures for evaluating these toxicities have been outlined which make use of a toxicity equivalence factor (TEF) (U.S. EPA 1989). A TEF has been assigned to each of the various 2,3,7,8-dioxins and furans based on their individual toxicities compared to 2,3,7,8-TCDD. The concentration each 2,3,7,8-isomer detected in a sample is multiplied by its TEF value. These are summed to indicate the samples' total toxicity equivalence to 2,3,7,8-TCDD. The TEF values for non-2,3,7,8-isomers are zero. Hence, a sample with no detectable concentration of 2,3,7,8-TCDD may still be considered toxic due to the presence of other isomers.

No detectable levels of 2,3,7,8-TCDD were reported in the site access road ditch sediment samples. Two samples (one being a duplicate) were collected from the drainage ditch that leads away from the large pond. Results indicate a detectable level of 1,2,3,4,6,7,8-HpCDD (heptachlorinated dibenzo-p-dioxin) at 0.1657J $\mu\text{g/kg}$ in one of the samples and a detectable level of OCDD (octachlorodibenzo-p-dioxin) at 6.8526J $\mu\text{g/kg}$ in the other. The only other detectable dioxin was 1.3803J $\mu\text{g/kg}$ OCDD in the ditch sample collected where the drainage ditch becomes parallel with the access road.

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No detectable levels were identified in the sample collected at the site boundary. The highest toxicity equivalence to 2,3,7,8-TCDD was recorded as 0.01.

4.2.1.2.1.2 Site Access Road Ditch Sediment Samples - Inorganics

The inorganic results for the site access road ditch sediment samples are reported in Tables 4.2-13 and 4.2-16. Chloride, total solids and pH are also reported. Arsenic levels detected in the south access road ditch and the saltwater pond ditch are elevated compared to the background soil levels reported in Section 4.1. The highest arsenic value reported was 27.6 mg/kg in the sample collected mid-way along the pond. Similar arsenic levels were detected in the upstream ditch samples along Route 167, Section 4.2.1.1.

The single cobalt value of 38.4 mg/kg for the Phase 1 access road ditch sediment sample, collected at the site boundary, is noticeably higher than the other ditch samples and the majority of background soil samples. Only in deeper boring soil samples, Section 4.4, were higher cobalt values reported. Lead was detected in the Phase 1 south access road ditch samples at 27.3J mg/kg and 75.3J mg/kg, which are higher than the other ditch sediments and the majority of background samples. These elevated levels were not duplicated in the Phase 2 samples, with the highest measured value being 15.1J mg/kg. Mercury was also detected in the two Phase 1 samples collected from the south access road ditch at 1.3 mg/kg and 0.25 mg/kg. The other south ditch samples had mercury levels below detection with the highest detection limit being 0.11U mg/kg.

Chloride levels of soils along the access road are also higher than the majority of background values. The highest detected chloride value was 1,257 mg/kg.

4.2.1.2.2 Site Access Road Water Samples

Site access road ditch surface water samples were analyzed for TCL organics and TAL inorganics, including cyanide, chloride, TOC and COD. Sample locations are shown on Figure 2.2-3.

4.2.1.2.2.1 Site Access Road Water Samples - Organics

The only volatile organic detected in the site access road ditch surface water samples was methylene chloride (Table 4.2-17). This compound, however, was also detected in the laboratory blanks.

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The only TCL semivolatile organic detected in the surface waters was diethylphthalate at 2J $\mu\text{g/l}$ in a duplicate of a surface water sample collected from the north access road ditch. A single semivolatile TIC was identified in each of the north access road ditch surface water samples with the higher of the two values being reported at 13J $\mu\text{g/l}$.

TOC and COD values, also reported on Table 4.2-17, show no indication of organic impacts to the surface waters on either side of the access road.

The only pesticide/PCB detected was aldrin at 0.1J $\mu\text{g/l}$ in the south access road ditch sample. Results are reported in Table 4.2-18.

4.2.1.2.2.2 Site Access Road Water Samples - Inorganics

The inorganic results for the site access road ditch surface water samples are reported in Table 4.2-19. Chloride, temperature, conductivity and pH are also reported. The south site access road ditch had a barium level of 531 $\mu\text{g/l}$ and the north access road ditch had levels of 329 $\mu\text{g/l}$ and 338 $\mu\text{g/l}$ in the two samples collected. As indicated in Section 4.2.1.1, the barium level downstream from the access road ditch confluence into the Route 167 ditch is higher than that measured upstream, 268 $\mu\text{g/l}$ versus 101B $\mu\text{g/l}$. It appears that barium is being carried off-site by surface runoff. The levels detected resulting in the off-site ditch are, however, no greater than levels detected on the west side of the highway.

The north access road ditch surface water sample had an elevated lead level of 21.4J $\mu\text{g/l}$. The duplicate of this sample had only 7.7J $\mu\text{g/l}$ possibly indicating that the lead is related to the suspended solids in the sample and is not in solution. Calcium, sodium and chloride were also elevated with the highest values being measured in the south access road ditch. The values are 23,800 $\mu\text{g/l}$ calcium, 66,100 $\mu\text{g/l}$ sodium and 135J mg/l chloride.

4.2.1.3 Southeast and Southwest Corners

The southwest corner of the property used to be the discharge location for the large pond. This discharge no longer occurs and drainage in the ditch that extends to the west is limited to runoff collected from off-site and the very southwest corner of the PAB site. Precipitation on the east side of the property drains to the south, collects and infiltrates the soil near the southeast corner. Runoff in this area was not observed leaving the property due to a systems of berms constructed around the property edge. During the Phase I investigation, a sediment sample was collected from both drainage areas to evaluate potential impacts. A water sample was also collected from the southeast area.

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Sufficient water was not present in the southwest drainage area to obtain a sample. Sample locations are shown on Figure 2.2-2. and 2.2-3.

4.2.1.3.1 Southeast and Southwest Corner Sediment Samples

The southeast and southwest corner site drainage/runoff sediment samples were analyzed for TCL organics, TAL inorganics including cyanide, chloride, TPH and pH.

4.2.1.3.1.1 Southeast and Southwest Corner Sediment Samples - Organics

The organic compounds detected in the southeast and southwest corner sediment samples are included in Tables 4.2-14 and 4.2-15. The only volatile organics detected were methylene chloride and acetone which were also detected in the associated laboratory blanks. The only semivolatile identified was benzoic acid at 57J $\mu\text{g}/\text{kg}$ in the southwest drainage ditch.

Various semivolatile TICs were also detected in the two corner sediment samples (Table 4.2-15). A greater number of TICs, at higher concentrations, were detected in the southwest ditch compared to the southeast area. Several of the TICs were identified as unknown hydrocarbons. A correlation between the TICs and TPH values cannot be made because the TPH values were determined to be unusable due to low matrix spike recovery. TPH values are therefore not reported.

No detectable levels of TCL pesticides or PCBs were found in either of the sediment samples (Table 4.2-18).

4.2.1.3.1.2 Southeast and Southwest Corner Sediment Samples - Inorganics

The inorganic results for the southeast and southwest corner sediment samples are reported in Table 4.2-16. Chloride, total solids and pH are also reported. The barium levels of 217 mg/kg and 217J mg/kg detected in the southwest and southeast ditches, respectively, are slightly higher than the majority of the background soil samples. The calcium levels of 2,410 mg/kg and 3,180 mg/kg are also higher than most of the background soil samples. Magnesium is also elevated in the southeast drainage ditch with a reported value of 2,990 mg/kg. The detection of thallium at 0.90J mg/kg is also higher than background levels.

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4.2.1.3.2 Southeast Corner Water Sample

The water sample, collected from the southeast corner drainage ditch, was analyzed for TCL organics, TAL inorganics including cyanide, chloride, TOC and COD. The sample location is shown on Figure 2.2-3.

4.2.1.3.2.1 Southeast Corner Water Sample - Organics

The only volatile organic compound detected in the southeast corner drainage ditch surface water sample is included in Table 4.2-17. Methylene chloride, detected at 8BJ $\mu\text{g/l}$, was also detected in the associated laboratory blank. There were no other organic compounds detected in the sample (Tables 4.2-17 and 4.2-18).

4.2.1.3.2.2 Southeast Corner Water Sample - Inorganics

The inorganic results for the southeast corner surface water sample are reported in Table 4.2-19. Chloride, temperature, conductivity and pH are also reported. The sodium level of 79,800 $\mu\text{g/l}$ is the only noticeably elevated inorganic compound when compared to the off-site drainage ways (Table 4.2-8). Chloride, at 7.5J $\mu\text{g/l}$, is much lower than the site drainage/runoff samples along Route 167.

4.2.2 Southeast Marsh Area

During the Phase 1 investigation, a sediment/soil and a surface water sample were collected from a marshy area located at the southeast end of the property, south of the south pit (Figures 2.2-2 and 2.2-3). Runoff from this area was not observed. The water collects, evaporates and infiltrates the soil. During Phase 1, this area was viewed as a possible seep from the south disposal pit as this area had never been viewed dry. However during Phase 2, this area was found to be dry and the idea of a possible seep was discounted. During Phase 2, seven soil samples, including a duplicate sample, were collected from the three locations shown on Figure 2.2-2. Two depth discrete samples were collected at each location, a 0-1 ft and a 2-3 ft sample.

4.2.2.1 Southeast Marsh Area Sediment/Soil Samples

During Phase 1, the sediment/soil sample was analyzed for TCL organics and TAL inorganics, including cyanide, chloride, TPH and pH. The same parameters were analyzed for during Phase 2 except cyanide, pesticides/PCBs and pH. These were excluded due to the non-detectable results and absence of abnormal pH reported from the Phase 1 sample.

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4.2.2.1.1 Southeast Marsh Area Sediment/Soil Samples - Organics

The volatile compounds detected in the southeast marsh area sediment/soil samples are included in Table 4.2-20. Methylene chloride and acetone were detected in the Phase 1 soil sample as well as the laboratory blank. The level of acetone detected, 260BD $\mu\text{g/kg}$, was evaluated as potentially not being fully the result of laboratory induced contamination. The Phase 2 investigation, however, only had acetone detected once and at a much lower level, 8J $\mu\text{g/kg}$ in the 2-3 ft soil sample collected at the west location. Tetrachloroethene was also detected in the Phase 1 soil/sediment sample at 9JD $\mu\text{g/kg}$. This compound was not detected in the Phase 2 soil samples. Additionally, the tetrachloroethene was only detected in the laboratory diluted sample. The first analysis indicated tetrachloroethene as undetected at 6U $\mu\text{g/kg}$. The presence of this compound may therefore be a lab-induced contaminant. The sample had been diluted and reanalyzed due to the detected elevated level of acetone.

The semivolatiles detected included diethylphthalate, di-n-butylphthalate and bis (2-ethylhexyl) phthalate. With the exception of diethylphthalate, at 29J $\mu\text{g/kg}$ in the 2-3 ft sample from the east location, all the southeast marsh soil/sediment samples had phthalates detected in the associated lab blanks also. The only other TCL semivolatile detected was 2-methylnaphthalene at 43J $\mu\text{g/kg}$ in the 0-1 ft sample from the west location.

Various semivolatile TICs were reported for the Phase 2 soil sample including unknown hydrocarbons and unknown alkanes (Table 4.2-21). The highest value reported was identified as an unresolved hydrocarbon complex with an estimated concentration of 1,120,000J $\mu\text{g/kg}$ in the 0-1 ft sample from the west location. The 2-3 ft sample from the east location had the least number of TICs identified with three.

The only detectable TPH value reported for the Phase 2 southeast marsh soil samples was for the 0-1 ft west location sample at 13I mg/kg (Table 4.2-20). The Phase 1 soil/sediment sample had a detectable concentration of 5.5 mg/kg.

Pesticide/PCBs were not detected in the Phase 1 sample and were therefore not analyzed for during Phase 2.

4.2.2.1.2 Southeast Marsh Area Sediment/Soil Samples - Inorganics

The inorganic results for the southeast marsh soil/sediment samples are reported in Table 4.2-22. Chloride, total solids and pH are also reported. The surface soils (0-1 ft) in the southeast marsh area contained barium levels greater than those found in background soil

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samples. The highest level was reported in the west location at a concentration of 4,370 mg/kg. The 2-3 ft samples were within the background levels reported. The west location also had elevated levels of calcium (4,580 mg/kg), cobalt (16.6 mg/kg), mercury (0.27 mg/kg), nickel (23.1 mg/kg) and zinc (277 mg/kg). Only cobalt (12.2B mg/kg) and nickel (25.6 mg/kg) remained elevated in the 2-3 ft sample. Cobalt was also elevated in the 0-1 ft sample from the east location (23.1 mg/kg) but decreased to 2.9B mg/kg in the 2-3 ft soil sample.

4.2.2.2 Southeast Marsh Area Water Sample

During Phase 1 the surface water sample collected from the southeast marsh area was analyzed for TCL organics, TAL inorganics, including cyanide, chloride, TOC and COD. The sample location is shown on Figure 2.2-3.

4.2.2.2.1 *Southeast Marsh Area Water Sample - Organics*

No volatile or semivolatile organics were detected in the water sample collected from the southeast marsh area (Table 4.2-17). TOC (40 mg/l) and COD (96 mg/l) values were slightly higher than those reported for other surface waters, however, this may be due to the marshy (decaying vegetation) nature of this area. The organic analysis provides no indication of contamination.

The only pesticide/PCB detected was beta-BHC at 0.20 $\mu\text{g/l}$ (Table 4.2-18).

4.2.2.2.2 *Southeast Marsh Area Water Sample - Inorganics*

The inorganic results of the surface water sample collected from the southeast marsh area are reported in Table 4.2-19. Chloride, temperature, conductivity and pH are also reported. Barium (669J $\mu\text{g/l}$), iron (6,920 $\mu\text{g/l}$) and manganese (2,320 $\mu\text{g/l}$) were detected at levels greater than that detected in off-site drainage paths. Arsenic, at 6.4B $\mu\text{g/l}$, was detected at higher values off-site but this value is the highest value recorded in on-site surface runoff.

4.2.3 Abandoned Canal

During the Phase 1 investigation, three sediment samples and three surface water samples were collected from the abandoned canal located east of the site. The sample locations are shown on Figures 2.2-2 and 2.2-3.

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4.2.3.1 Abandoned Canal Sediment Samples

The sediment samples from the canal were analyzed for TCL organics, TAL inorganics, including cyanide, chloride, TPH and pH.

4.2.3.1.1 *Abandoned Canal Sediment Samples - Organics*

The volatile organic compounds detected in the abandoned canal sediment samples are included in Table 4.2-14. Methylene chloride, acetone and chloroform were detected in the samples as well as in the laboratory blanks and therefore are considered attributable to laboratory impact. The only other volatile organic detected was 4-methyl-2-pentanone at 2J $\mu\text{g}/\text{kg}$ in the middle canal sediment.

The semivolatile analysis (Table 4.2-14) revealed low levels of benzoic acid in all three canal sediment samples. The highest reported value, 150J $\mu\text{g}/\text{kg}$ occurred in the north canal sediment sample. Benzo(a)pyrene was detected at 100J $\mu\text{g}/\text{kg}$ and 97J $\mu\text{g}/\text{kg}$ in the south canal and north canal sediment samples, respectively. The only other TCL semivolatile was bis (2-ethylhexyl) phthalate at 75J $\mu\text{g}/\text{kg}$ in the north canal sediment.

Various unknown semivolatile TICs were also detected in the canal samples (Table 4.2-15). The two highest concentrations were detected as unknown TICs at 3,000J $\mu\text{g}/\text{kg}$ identified in the south and the middle canal sediment samples. TPH values were determined to be unusable due to low matrix spike recovery and are therefore not reported.

No detectable levels of TCL pesticides or PCBs were found in the sediment samples.

4.2.3.1.2 *Abandoned Canal Sediment Samples - Inorganics*

The inorganic results of the canal sediments are reported in Table 4.2-16. Chloride, total solids and pH are also reported. Mercury was detected in the south and the middle canal sediments at 0.20 mg/kg and 0.14 mg/kg, respectively. The north canal sediment reported mercury as undetected 0.15U mg/kg.

4.2.3.2 Abandoned Canal Water Samples

The surface water samples collected from the abandoned canal were analyzed for TCL organics, TAL inorganics, including cyanide, chloride, TOC and COD. The sample locations are shown on Figure 2.2-3.

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4.2.3.2.1 Abandoned Canal Water Samples - Organics

The organic compounds detected in the surface water samples are included in Tables 4.2-17 and 4.2-18. The only volatile organic detected was methylene chloride which was also detected in the associated laboratory blank. The only TCL semivolatile detected was bis (2-ethylhexyl) phthalate at 31 $\mu\text{g/l}$ in the south canal surface water sample. The only semivolatile TICs identified were in the north canal surface water sample. These compounds were also detected in the laboratory blank. TOC and COD values reported for the canal surface water samples (Table 4.2-17) provide no indication of contamination. No detectable level of TCL pesticides or PCBs were found in the canal water samples (Table 4.2-18).

4.2.3.2.2 Abandoned Canal Water Samples - Inorganics

The inorganic results of the canal water samples are reported in Table 4.2-19. Chloride, temperature, conductivity and pH are also reported. The levels detected were not greater than concentrations found in off-site drainage ditches. In most instances, the canal water samples produced values which were much lower.

4.3 CONTAMINANT SOURCES

The potential contaminant source areas investigated during the field activities include: the ponds, the disposal pits and the storage tanks.

4.3.1 Saltwater Pond

During the Phase 1 investigation, several sediment and surface water samples were collected from the main body of the saltwater (large) pond. A surface water sample and a duplicate surface water sample were collected using a HDPE beaker. The sample was composited from four different locations: southwest, northwest, southeast and northeast areas of the pond. A subsurface sample was collected by using a subsurface grab sampler. This sample was composited from the same four locations as the surface water samples. Four sediment samples were also collected at these same 4 locations with a S.S. hand auger. The samples collected from the southwest and northwest areas of the pond were taken from the top 1 ft of sediment. The sample collected from the southeast corner of the pond was collected from the 1-2 ft depth. The sample collected from the deeper pit area, in the northeastern corner of the pond, was collected from the 1.5-2.5 ft depth of sediment. The sampling locations are shown in Figures 2.2-3 and 2.3-1.

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During the Phase 2 investigation, the sampling effort was concentrated toward two areas within the large body of the saltwater pond. The southeast corner of the pond and the pond islands (mounds) were examined in greater detail. The southeast corner was studied by probing and collecting samples to determine the extent of the visually contaminated, black sludge/sediment and to search for a possible piping connection between the pond and the south disposal pit. The pond islands were sampled to find out if they were, at one time, used as disposal mounds and to characterize any waste material that may remain. The sampling locations are shown in Figure 2.3-2.

Although the Phase 1 investigation identified a deeper pit area in the northeast corner of the pond, the Phase 1 analytical results did not indicate that this area had been utilized for disposal. Additional investigation of the sediments in this area was therefore not conducted in Phase 2.

During Phase 2, one additional surface water sample was collected from the pond, at the point of discharge, near the former tank area. This location is shown on Figure 2.2-3.

4.3.1.1 Saltwater Pond Sediments

The saltwater pond sediment samples collected during Phase 1 were analyzed for TCL organics, TAL inorganics, cyanide, TPH and pH. During Phase 2, the pesticide/PCB analysis, cyanide and soil pH analyses were excluded as detectable levels of pesticide/PCBs or cyanide and abnormal pH values were not identified during Phase 1. The sediment/clay samples collected in Phase 2 were also analyzed for dioxins and furans. This was performed to check for the possible past disposal of unknown chemical wastes at the site.

4.3.1.1.1 *Saltwater Pond Sediments - Organics*

The volatile organic compounds detected in the saltwater pond sediments are included in Table 4.3-1. Methylene chloride and acetone were detected in most of the samples as well as the laboratory blanks and are considered attributable to laboratory impacts. During the Phase 1 sampling effort the only sediment sample that had any detectable volatile TICs was the sample from the southeast corner. This sample was reported to contain 14J $\mu\text{g}/\text{kg}$ of an unknown hydrocarbon. During the Phase 2 investigation, the only sample that had identified volatile TICs was the sample collected at the suspected discharge pipe from the south pit. This material was an oily black sediment with a petroleum odor and contained various cyclohexanes, the highest of which is reported as 80J $\mu\text{g}/\text{kg}$. The underlying clay sample did not have any volatile TICs reported.

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The only TCL semivolatiles detected in the Phase 1 saltwater pond sediment samples (Table 4.3-2) were from the southeast corner. Phenanthrene (280J $\mu\text{g/kg}$), 2-methylnaphthalene (210J $\mu\text{g/kg}$) and bis (2-ethylhexyl) phthalate were detected. This sludge sample also had numerous semivolatile TICs detected including several substituted naphthalenes (Table 4.3-4). The highest single compound was 12,000J $\mu\text{g/kg}$ of an unknown hydrocarbon. The other saltwater pond sediment samples had only minor semivolatile TICs detected, similar to those detected in the background soil samples.

The Phase 2 saltwater pond sediment samples detected numerous polycyclic aromatic hydrocarbons (PAHs) in the southeast corner of the large pond (Tables 4.3-2 and 4.3-3). The highest concentrations were 2-methylnaphthalene (5,670 $\mu\text{g/kg}$), phenanthrene (2,750 $\mu\text{g/kg}$) and fluorene (1,070J $\mu\text{g/kg}$) in the sample collected by the south pit discharge pipe (ID #301B-10-91). The only semivolatile detected in the clay sample, collected from beneath the sediment, was 110J $\mu\text{g/kg}$ of di-n-butylphthalate. The other sediment samples indicated much less semivolatile contamination radiating in an outward direction from the discharge pipe.

The largest concentrations of semivolatile TICs (Tables 4.3-4 and 4.3-5) were also identified in the sediment sample collected by the south pit discharge pipe (ID #301B-10-91). The majority of compounds were identified as substituted naphthalenes and unknown hydrocarbons. The concentrations of individual compounds were as high as 34,000J $\mu\text{g/kg}$. The underlying clay sample had much lower concentrations of TICs detected. Concentrations and the number of compounds detected in the sediment samples significantly drop off as their locations move to the west and northwest, toward the main portion of the pond.

As shown in Tables 4.3-6 and 4.3-7, OCDD (octachlorodibenzo-p-dioxin) was detected at low levels in all but two of the Phase 2 saltwater pond sediment samples. The highest value of OCDD was 2 4438J $\mu\text{g/kg}$. The only other compound detected was 0.2916J $\mu\text{g/kg}$ of 1,2,3,4,6,7,8-HpCDD (heptachlorodibenzo-p-dioxin) in sample ID #303-10-91 collected near the southern bank in the southeast corner. Due to the low values detected and the lower relative toxicities of these compounds compared to 2,3,7,8-TCDD, all pond sediment samples were calculated to have a toxicity equivalence to 2,3,7,8-TCDD of less than 0.01 $\mu\text{g/kg}$.

No detectable level of TCL pesticides or PCBs were found in any of the Phase 1 saltwater pond sediment samples. As indicated previously, Phase 2 sediment samples were not analyzed for pesticides or PCBs.

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Tables 4.3-2 and 4.3-3 also present the results of the TPH analysis. The Phase 1 sediment analysis for TPH was determined to be unusable due to low matrix spike recovery and is not reported. The Phase 2 analysis shows agreement with the semivolatile analysis results in that the highest TPH value was reported for the saltwater pond sediment sample collected by the discharge pipe at 4,167 mg/kg. The underlying clay had an undetected level at 27U mg/kg. Levels were greatly reduced in the outlying samples.

4.3.1.1.2 Saltwater Pond Sediments - Inorganics

The inorganic results for the saltwater pond sediment samples are presented in Tables 4.3-8 and 4.3-9. Chloride, total solids and pH are also reported. Compared to background soil samples, barium is noticeably elevated in the sediment in the large pond with levels being much higher in the southeast corner. Levels detected in the southwest end (375J mg/kg) and the northwest end (329J mg/kg) are elevated compared to background soils but are less than levels detected off-site in background ditch sediments. The highest value recorded was 9,860J mg/kg in the sediment sample collected at the western limit of the Phase 2 sampling effort conducted in the southeast corner (ID #309-10-91). The clay sample collected from beneath the sediment at the south pit discharge pipe was recorded at 123J mg/kg which is comparable to background soil values.

Compared to background soils, elevated levels of calcium, chromium, cobalt and zinc were also reported in the southeast corner. Arsenic was elevated in two sediment samples (ID #301B-10-91 and 305-10-91) at 14.5J and 14.2J mg/kg, respectively. Lead was also elevated in sample ID #305-10-91 at 51.8J mg/kg. Sodium was noticeably higher in only the clay sample (ID #302-10-91) at 1,120B mg/kg. Chloride levels were not measured above background levels.

The saltwater pond sediment samples were also screened in the field for radiation using a hand held radiation meter. This was done to check for potential naturally occurring radiation associated with oil and gas exploration and production. No readings above background were detected in any of the samples.

4.3.1.2 Saltwater Pond Water

The saltwater pond water samples collected during Phase 1 were analyzed for TCL organics, TAL inorganics, cyanide, chloride, TOC and COD. For the Phase 2 water sample collected, the COD analysis was replaced with TPH.

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4.3.1.2.1 Saltwater Pond Water - Organics

The only volatile organic compound detected in the saltwater pond water was methylene chloride (Table 4.3-10). This compound was also detected in the laboratory blank and is considered attributable to laboratory influence.

The only TCL semivolatile detected in the Phase 1 water samples (Table 4.3-11) was benzo(g,h,i)perylene at 6J $\mu\text{g/l}$. The only TCL semivolatile detected in the Phase 2 water sample was bis (2-ethylhexyl) phthalate at 11JB $\mu\text{g/l}$, which was also detected in the laboratory blank. Only one non-blank related TIC was detected in the Phase 1 samples, 9J $\mu\text{g/l}$ of an unknown compound. The Phase 2 sample had eight non-blank related TICs detected, the highest was recorded at 7J $\mu\text{g/l}$ of an unknown. Although an indication of contamination is not evident, the TOC value of 30.5 mg/l in the Phase 2 sample is higher than the greatest value of 11.0J mg/l detected in Phase 1. TPH was measured in Phase 2 at 1.25 mg/l.

The pesticides aldrin and endosulfan I were detected at very low levels in the Phase 1 saltwater pond water samples (Table 4.3-12). These compounds were undetected in the Phase 2 sample. As shown in Table 4.3-12, various other pesticides were detected in the Phase 2 sample. The values are all estimated due to the extremely low concentration reported and difficulty in quantifying the results.

4.3.1.2.2 Saltwater Pond Water - Inorganics

The inorganic sample results for the saltwater pond water samples are presented in Table 4.3.13. Initially, during Phase 1, three composite water samples were collected from the large pond. A sample of subsurface water, taken near the bottom of the pond, and two surface water samples, gathered from the top 1 foot, were collected. Elevated levels of barium were present in the samples, the highest level being 1,550 $\mu\text{g/l}$. Calcium, sodium and chloride were also elevated compared to off-site ditch samples and canal samples. The analytical results of these initial samples became available while field work was on going during Phase 1. Based on the results, two additional samples were collected from the large pond for inorganic analysis, one was filtered (0.45 micron), ID #621-03-91, and the other was analyzed for total metals as done previously, ID #620-03-91. The samples were collected from the pond immediately prior to the pond outfall, southwest of the tank area. Elevated barium (2,890 $\mu\text{g/l}$) and chromium (21.7 $\mu\text{g/l}$) were detected in the sample analyzed for total metals. Calcium and sodium were also elevated. The filtered sample showed a 47% reduction in the barium level, down to 1,380 $\mu\text{g/l}$. Chromium was reduced to below detection at 2U $\mu\text{g/l}$. The calcium and sodium levels showed no reduction. Although not originally elevated compared to other surface water samples,

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the levels of aluminum, iron, lead, magnesium, manganese and potassium also showed a decrease in the filtered sample.

Two additional surface water samples (ID #301A-10-91) were collected from the saltwater pond at the outfall location during Phase 2. One was filtered and one was analyzed for total metals. As with the previous samples, barium and chromium were elevated in the total analysis. Higher values of aluminum, copper and manganese were also detected. A marked reduction in filtered values was again realized in the majority of metals. The only discrepancy noted was for zinc. The reported value increased from 22.2U $\mu\text{g/l}$ to 245 $\mu\text{g/l}$ in the filtered sample. This larger value is suspect based on the undetected levels previously reported in the Phase 1 data and the unfiltered Phase 2 sample.

4.3.1.3 Islands/Mounds

The islands (raised soil mounds) in and near the large pond were investigated during Phase 2. The sampling locations are shown on Figure 2.3-2. These areas were suspected of possibly being waste material that was deposited during past site operations. At each location a surface (0-1 ft) and subsurface (2-3 ft) soil sample were collected and analyzed for TCL organics, TAL inorganics, TPH and chloride. During the sampling, no visual identification of waste or oily material was made.

4.3.1.3.1 *Islands/Mounds - Organics*

The volatile organic compounds detected in the island/mound soil samples are included in Table 4.3-15. Acetone was detected in many of the samples as well as the related laboratory blanks. The only other volatile compound detected was 2-butanone, which was detected in the deeper sample collected from the soil mound near the north end of the pond (ID #246-10-91). Although not detected in the associated lab blank, 2-butanone is a common laboratory contaminant and, based on other site sample results, its presence is not suspected at the site.

The semivolatile organic results are presented in Table 4.3-16, 4.3-17 and 4.3-18. There were only three semivolatile compounds detected in all of the island/mound samples. These compounds are all common laboratory contaminants: bis(2-ethylhexyl)phthalate, di-n-butylphthalate and diethylphthalate.

Various semivolatile TICs were detected in the island/mound soil samples. There is a noticeable correlation between the total concentrations and the depth of the sample. Higher levels were consistently found in the surface (0-1 ft) samples. Most of the TICs

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were identified as unknowns, unknown alkanes or unknown hydrocarbons. One set of noticeable results were for the surface sample collected from the island west of the former tank battery (ID #243-10-91) which identified the material present as C₂₃ through C₃₁ alkanes.

Although various semivolatile TICs were detected, the TPH values reported for the samples were all below the detection limits (28U - 32U mg/kg). Results are reported on Tables 4.3-16, 4.3-17 and 4.3-18. In all but sample ID #245-10-91, these detection limits are above the total concentration of all non-lab associated semivolatile TICs.

Pesticide/PCB concentrations in all the samples were below detectable levels.

4.3.1.3.2 *Island/Mounds - Inorganics*

The inorganic island/mound soil sample results are presented in Tables 4.3-22, 4.3-23 and 4.3-24. Chloride and total solids are also reported. Because the soil is not in its natural state (has been previously excavated) the values obtained were compared to the background soil values measured for both the 0-1 ft depth and the 1-3 ft depth soils, as previously shown in Table 4.1-A in Section 4.1.

Calcium and magnesium were found to be elevated in the majority of samples. Only one sample (ID #236-10-91) was found to contain noticeably elevated values of several other metals including barium (304 mg/kg), beryllium (2.2 mg/kg), cobalt (15.4 mg/kg) and nickel (26.6 mg/kg). The only other samples that had elevated elements were sample ID #212-10-91 with a cobalt level of 13.9 mg/kg and sample ID #235-10-91 with sodium at 816B mg/kg and chloride at 1,442 mg/kg.

4.3.2 Northwest Pond

During the Phase 1 field investigation, sediment and surface and subsurface water samples were collected from the northwest pond and the adjacent low area. During the Phase 2 study, an elongated mound of soil located in the northeastern corner of the area was sampled to evaluate the potential that it contained waste material from past site operations. The sample locations are shown on Figure 2.2-3 and 2.3-1.

4.3.2.1 Northwest Pond Sediments/Mound

The sediment samples and soil samples collect from the mound in the northwest pond area were analyzed for TCL organics, TAL inorganics, chloride and TPH. Sediment samples were also analyzed for cyanide and pH.

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4.3.2.1.1 Northwest Pond Sediments/Mound - Organics

The volatile organic results of the northwest pond area sediment and soil samples are presented in Table 4.3-25. Methylene chloride and acetone were detected in many of the samples as well as the laboratory blanks and are considered attributable to laboratory influence.

The only TCL semivolatiles detected (Table 4.3-25) were phthalate esters in the mound soil samples. All the values reported were below the normal quantitation limits.

Only a minor level of semivolatile TICs (Table 4.3-26) were detected in the northwest pond sediments, similar to background soil detection. Several unknown hydrocarbons were identified in the mound soils, however, all were at low concentrations. The highest value was 670J $\mu\text{g/kg}$ in a 2-3 ft sample. Numerous laboratory blank contaminants were also detected.

The results for TPH are presented in Table 4.3-25. Only one mound soil sample had a detectable level of 55.0J mg/kg . The TPH results for the northwest pond sediment samples were determined to be unusable due to low matrix spike recovery and are not reported.

Pesticides or PCBs were not detected in the northwest pond sediment samples (Table 4.3-27). Endosulfan I and endosulfan II were detected at very low levels in the mound soil. The values were estimated due to the low detected concentration and difficulty in quantifying the results. Endosulfan II was also detected in the associated laboratory blanks.

4.3.2.1.2 Northwest Pond Sediments/Mount - Inorganics

The inorganic results from the northwest pond area soil and sediment samples are presented in Table 4.3-28. Chloride, total solids and pH are also reported. Compared to background soils, the sediment samples from the northwest pond had a slightly elevated concentration of barium in the samples collected from the east side of the pond (Figure 2.3-1) at 274J mg/kg and 288J mg/kg for the two samples. Cobalt values were also slightly higher than background at 17.9 mg/kg and 17.8 mg/kg . Levels of calcium, magnesium, nickel, potassium and zinc were also slightly higher in the east side samples compared to background.

An arsenic value of 13.7J mg/kg was reported in the sediment sample from the adjacent low area. This value, as well as the other northwest pond sediment values, may be 49%

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low due to matrix interference and low matrix spike recovery achieved by the laboratory. The arsenic levels in the low area and the northwest pond may therefore be slightly higher than concentrations detected in the background samples.

The northwest pond sediment samples were also screened in the field for radiation using a hand held radiation meter. This was done to check for potential naturally occurring radiation associated with oil and gas exploration and production. No readings above background were detected in any of the samples.

The only inorganic constituent detected above background levels in the sample collected from the mounded area was a single value of cobalt at 10.2J mg/kg. The highest background cobalt level detected in soils down to 3 ft was 9.8B mg/kg. Higher cobalt values were detected in deeper background samples.

4.3.2.2 Northwest Pond Water

The water samples collected from the low area and the northwest pond were analyzed for TCL organics, TAL inorganics, cyanide, chloride, TOC and COD.

4.3.2.2.1 Northwest Pond Water - Organics

The volatile organic results of the northwest pond waters are presented in Table 4.3-10. Methylene chloride was the only volatile compound detected and it was also identified in the laboratory blank, therefore its presence is attributed to laboratory influence.

No TCL semivolatiles were detected in the samples and only one semivolatile TIC was detected in each of the three water samples collected (Table 4.3-11). For two of the samples, the compound was also detected in the laboratory blank, therefore their presence is uncertain. The only other TIC detected was an unknown compound at 30J $\mu\text{g/l}$ identified in the northwest pond subsurface water sample. TOC and COD values, also reported on Table 4.3-11, show no indication of organic impacts to the ponded water.

No pesticides or PCBs were detected in the water samples, as shown in Table 4.3-12.

4.3.2.2.2 Northwest Pond Water - Inorganics

The inorganic results for the northwest pond water samples are presented in Table 4.3-14. Compared to off-site surface waters, the northwest pond water and the low area water was not found to contain any inorganics at elevated levels. The highest total

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barium level was 151B $\mu\text{g/l}$ in the low area which is much lower than the surface waters in the site ditches.

4.3.3 Northwest Disposal Pit Sludge/Clay

During the field investigations, sludge and underlying clay samples were collected from the northwest pit at four sample locations. The sample locations are shown on Figure 2.3-3. No surface water was present in this pit. The collection of the samples was performed by placing a 4 inch PVC pipe down through the sludge into the clay and obtaining the sample with a S.S. hand auger from inside the pipe casing.

The north, middle and south locations were sampled during Phase 1. Sludge samples were collected at the north location at depth intervals from 0-2 ft, 7-9 ft and 14-15.5 ft.

Underlying clay samples were collected at this location at depth intervals of 16-16.5 ft and 18-18.75 ft. At the middle location, sludge samples were obtained from 0-0.5 ft and 11.5-14 ft depths with a duplicate sample taken at the 11.5-14 ft interval. Clay samples were collected at this location from the 15.5-16.25 ft depth and the 18-19 ft depth with a duplicate sample collected at the 18-19 ft interval. Sludge samples were obtained from the south location at depths of 4-5 ft, 9.5-10.5 ft and 14-15 ft. Clay samples were obtained at this location at 16.5-17.5 ft and 19-20 ft depth intervals. The samples were analyzed for TCL organics, TAL inorganics, cyanide, chloride, TPH and pH. The sludge samples were also analyzed for flash point, for heat of combustion and TCLP. The TCLP extract was analyzed for TCL organics and TAL inorganics.

The Phase 2 sampling of the northwest pit was performed at the north-central location, shown on Figure 2.3-3. Sludge samples were collected at depth intervals from 3-4 ft, 5-6 ft, 7-8.5 ft (including a duplicate sample), 9-10 ft and 11-12 ft. The underlying clay was sampled at depth intervals of 15.5-17 ft (including a duplicate sample) and 17.5-18.5 ft.

Due to the presence of high levels of oily, long chain hydrocarbons found in all three disposal pits during Phase 1, the achievable detection limits were elevated relative to "normal" thereby reducing the usefulness of the data. In an effort to reduce the interference encountered in Phase 1, the Phase 2 samples were analyzed for TCL organics following extraction by modified extraction/clean-up procedures. Several of the samples were also analyzed by the routine CLP organic procedure to enable a comparison of the two methods. The samples were also analyzed for TAL inorganics, TPH, chloride and dioxins and furans.

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4.3.3.1 Northwest Disposal Pit Sludge/Clay - Organics

The volatile organic results for the northwest pit sludge/clay samples are presented in Tables 4.3-29, 4.3-30 and 4.3-31. Flash point and heat of combustion are also presented in these tables for the Phase 1 data. Volatile TICs are presented in Tables 4.3-32 through 4.3-35. Due to the oily nature and the presence of relatively high organic concentrations in the samples, the detection limits achieved are high.

Methylene chloride and acetone were detected in many of the samples as well as in the majority of the associated laboratory blanks and quality assurance (QA) samples. 2-Butanone was also detected in some of the samples even though it was not detected in the associated laboratory blanks or QA samples. All three compounds are common volatile laboratory contaminants. Acetone, however, is also suspected to be present in other pit samples and in at least one of the tanks, therefore, it cannot be completely dismissed as laboratory based contamination. The highest acetone value reported occurred in the 4-5 ft sludge sample of the south location at a concentration of 8.2J mg/kg. Chloroform was detected in most of the sludge and clay samples collected during Phase 2. Although it is not considered a common laboratory blank, chloroform was detected in at least one of the associated laboratory blanks and in some QA samples.

The sludge and clay samples from the northwest pit were also found to contain benzene. The highest detected concentration for benzene occurred in the 7-9 ft sludge sample from the north location at a value of 6.6J mg/kg. Toluene, ethyl benzene and xylenes were also reported in the samples. The highest detected values, 27.0J, 15.0J and 75.0J mg/kg, respectively, for the three compounds occurred in the same sample as the highest benzene value. The detectable levels of these compounds were still present in the underlying clay samples but at greatly reduced values. The highest detectable value found in the clay for benzene was 0.12J mg/kg in the 15.5-17 ft duplicate Phase 2 sample.

Various volatile TICs were also identified for the samples, the majority of which were alkanes, alkyl benzenes and unknown hydrocarbons. The concentrations of individual compounds were as high as 220JN mg/kg. There was a decrease in concentration in the clay samples but detectable contamination was still present at values up to 130JN mg/kg.

The semivolatile analysis results for the northwest pit sludge and clay samples are presented in Tables 4.3-36 and 4.3-37 for the Phase 1 data and Tables 4.3-38 and 4.3-39 for the Phase 2 data. The TPH results are also presented on these tables. The semivolatile TIC results are presented in Tables 4.3-40 and 4.3-41 for the Phase 1 data and Tables 4.3-42 and 4.3-43 for the Phase 2 data. As with the volatile analysis, the oily nature of the samples caused interference resulting in some elevated detection limits for

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the semivolatile compounds in the Phase 1 data. The modified extraction/ clean-up procedure was used on the majority of the Phase 2 samples.

A total of 17 semivolatile compounds were detected in the northwest pit sludge/clay. The results indicated the presence of numerous polycyclic aromatic hydrocarbons (PAHs) including naphthalene, 2-methylnaphthalene, fluorene, phenanthrene and pyrene. The highest reported compound in the sludge was 2-methylnaphthalene at 540J mg/kg. The highest concentrations of naphthalene, fluorene, phenanthrene and pyrene were reported as 200J, 55J, 95J and 4.3J mg/kg, respectively. The detected compounds in the clay samples were reported at levels less than the sludge samples but still had significant concentrations.

The modified extraction/clean-up procedure utilized for the semivolatile Phase 2 samples did not appear to have made a consistent difference in the detected values and detection limits when the results are compared to the RAS results (Tables 4.3-38 and 4.3-39). Sample number SF 2039, performed by the modified analysis, reported greater detected values and also detection limits than did its duplicate sample, FT 008, which utilized the RAS analysis. In part, this is due to the fact that Phase 2 RAS results are also reported at lower detection limits compared to the Phase 1 results.

Poor comparisons between the other Phase 2 duplicates collected from the northwest pit are also noticeable. The sample numbers SF 2042 and SF 2045 were both analyzed by the modified procedure, however, SF 2042 was analyzed as a medium-level sample and SF 2045 was analyzed as a low-level sample. The results reported for the modified analysis sample SF 2048, which was analyzed as a low-level sample, and the RAS sample FT 009, which was analyzed as a medium-level sample also exhibit poor comparison. The useability of these Phase 2 results is therefore limited.

The TPH results are reported on the semivolatile organics tables. The TPH values in the sludge ranged up to 149,000 mg/kg (14.9%). The TPH values of the clay were still relatively high, but significantly less than the sludge values. The highest TPH reported in the clay was 11,800 mg/kg.

The semivolatile TICS reported for the samples consist primarily of naphthalene isomers, alkanes and various unidentified compounds. The concentration of individual compounds were as high as 3,900JN mg/kg in the sludge. Although concentrations were greatly reduced, the clay samples still had numerous detectable TICs. The greatest value reported in the underlying clay was 570J mg/kg.

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Results of the northwest pit sludge/clay pesticide/PCB analyses are presented in Tables 4.3-44 through 4.3-47. During Phase 1, numerous compounds were detected, however, due to interference from the matrix, false positive are suspected. Most of the data is qualified due to compounds failing percent RSD linearity criteria and percent D criteria for quantitation.

There are only six pesticide values not qualified in the Phase 1 data. The compounds and their detected values are endosulfan I (0.012 mg/kg) and alpha chlordane (0.0057 mg/kg) in the 7-9 ft sludge sample from the north location, aldrin (0.0067 mg/kg) in the 0-0.5 ft and endrin (0.0073 mg/kg) in the 11.5-14 ft middle location sludge sample and endrin (0.0081 mg/kg) and alpha chlordane (0.0071 mg/kg) in the 14-15 ft south location sludge sample.

The Phase 2 pesticide/PCB analysis also detected numerous compounds. The modified extraction/clean-up procedure was utilized, however, it was not as effective as hoped for because there was still significant interference from the sample matrices. Again, with the exception of four values, all of the data is qualified. The four compounds and their detected values are endosulfan sulfate (0.0110 mg/kg) and 4,4'-DDT (0.0090 mg/kg) in the 5-6 ft sludge sample, endosulfan II (0.0096 mg/kg) in the 5-6 ft duplicate sludge sample and endrin ketone (0.0088 mg/kg) in the 9-10 ft sludge sample. When the comparison is made between the RAS samples (sample numbers labeled FT) and the modified samples (sample numbers labeled SF), it appears as if the modified method may have effected contaminant levels as more undetected values were reported than for the duplicate RAS samples.

The dioxin and furan results for the northwest pit sludge/clay Phase 2 investigation appear in Tables 4.3-48 and 4.3-49. 2,3,7,8-TCDD was detected in one sludge sample at a concentration of 0.0375J $\mu\text{g/kg}$. The only other dioxin/furan detected was OCDD (octachlorodibenzo-p-dioxin). This was detected in three sludge samples at concentrations from 1.7800J $\mu\text{g/kg}$ to 4.0167J $\mu\text{g/kg}$. OCDD was also detected in a clay sample at a concentration of 0.9199J $\mu\text{g/kg}$. The sample which detected 2,3,7,8-TCDD produced a toxicity equivalence value of 0.04 $\mu\text{g/kg}$. None of the other samples had a reported toxicity equivalence to 2,3,7,8-TCDD above 0.01 $\mu\text{g/kg}$.

4.3.3.2 Northwest Disposal Pit Sludge/Clay - Inorganics

Inorganic sample results for the northwest pit sludge/clay are presented in Tables 4.3-50 through 4.3-53. Chloride, total solids and pH results are also presented in these tables. The highest single value detected was for barium at a concentration of 46,500 mg/kg. A high barium result is not unexpected since a portion of the material known to have

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been received at PAB were wastes which contained various amounts of drilling mud. Drilling mud commonly utilizes barite, a barium sulfate mineral, as a weighting agent.

Five other metals were identified at concentrations which were significantly higher in the sludge samples compared to the underlying clay and background samples. The highest values detected for each metal were: 32,000 mg/kg calcium, 933J mg/kg chromium, 685J mg/kg copper, 2,780J mg/kg lead and 3,610J mg/kg zinc. Mercury was also elevated in all but two of the sludge samples. The highest value detected for mercury was 2.6 mg/kg.

Arsenic, cadmium and selenium were found to be elevated in some of the sludge samples when compared to background values and the underlying clay. The maximum concentrations reported for the three metals were 25.1 mg/kg arsenic, 11.8 mg/kg cadmium and 1.3B mg/kg selenium. Compared to background levels, the majority of the samples, including the clay samples, had elevated levels of sodium. Magnesium and manganese concentrations were elevated in many of the clay samples. This appears to be a natural condition due to the lack of elevated levels in the sludge.

The chloride and pH analyses produced elevated values in the northwest pit. The sludge and underlying clay have maximum chloride concentrations of 14,800 and 7,997 mg/kg, respectively, as compared to the maximum reported background value of 753 mg/kg. The background soil pH ranged from 5.4 to 6.4 while the sludge pH ranged from 8.2 to 12.0 and the clay pH ranged from 6.7 to 8.0.

The northwest pit sludge/clay samples were also screened during the Phase I field investigation for radiation using a hand held radiation meter. No readings above background were detected in any of the samples.

4.3.3.3 Northwest Disposal Pit Sludge - TCLP Analysis

The TCLP was run on the sludge samples collected from the northwest pit during Phase I of the field investigation. The TCLP extract was then analyzed for TCL organic and TAL inorganic parameters. Results are presented in Tables 4.3-54 through 4.3-58. No compounds were found to exceed the TCLP regulatory levels as listed in 40 CFR 261. Although elevated levels were detected, benzene did not exceed the 500 µg/l regulatory level. The results did confirm the presence of benzene, ethyl benzene, toluene, xylenes and various alkyl benzenes. The semivolatile analysis results indicate the presence of phenols, naphthalenes and various other PAHs.

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4.3.4 Northeast Disposal Pit Sludge/Clay/Scum

During the field investigations, sludge, underlying clay and floating scum samples were collected from the northeast disposal pit. The four sample locations are shown in Figure 2.3-5. Water samples were also collected and are discussed in Section 4.3.7. The sludge and underlying clay samples were obtained by placing a 4 inch PVC pipe through the water column into the sludge and then into the underlying clay. This pipe was used as a casing, the water column inside the casing was removed and the sludge and clay was sampled with a S.S. hand auger.

Three sludge/clay locations, north, middle and south areas of the disposal pit, were sampled during Phase 1. At the south location, sludge samples were collected at 9-10.5 ft and 11.5-13.5 ft depths. A clay sample was collected at the 15.5-17 ft depth. At the middle location, a sludge sample and a duplicate sludge sample were collected at the 8-11 ft depth interval. A separate sludge sample was collected at the 12-13 ft depth. Clay samples were collected at the 15-16 ft and 18-19 ft depth intervals. At the north location, sludge samples were collected from the 8-10 ft and 12-13 ft depth intervals. Clay samples were obtained at the 16-17 ft and 18-19 ft depth intervals. The upper clay samples from the middle and north locations had a visible dark oil in the pore spaces in addition to a fuel odor.

The Phase 1 sludge samples were analyzed for TCL organics, TAL inorganics, cyanide, TPH, pH, chloride, flash point and heat of combustion. The sludge samples were also tested by the TCLP. The TCLP extract was analyzed for TCL organics and TAL inorganics. The middle sludge sample at the 12-13 ft depth was further analyzed for viscosity and percent ash. The underlying clay samples were analyzed for TCL organics, TAL inorganics, cyanide, TPH, pH and chloride. The middle clay sample at the 15-16.5 ft depth was further analyzed for flash point and heat of combustion.

One half of the northeast disposal pit was covered with a floating scum layer which moved from end to end depending upon the wind direction. A composite sample was collected during Phase 1 from this scum layer by collecting several grab samples at the locations shown on Figure 2.2-3. The scum layer was analyzed for TCL organics, TAL inorganics, cyanide, flash point, heat of combustion, viscosity and percent ash.

The Phase 2 sample location, between the north and middle Phase 1 locations (Figure 3.3-5), included six sludge samples and two clay samples. The sludge samples were collected from depth intervals of 8-9.5 ft, 10-11.5 ft, 9.5-10.5 ft and 11.5-12.5 ft. A duplicate sample was collected from the 10-11.5 ft range. The underlying clay was sampled at depth intervals of 15-16 ft and 16.5-17.5 ft.

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The third sludge sample (9.5-10.5 ft) appears to be out of sequence, although it was collected after the 10-11.5 ft samples. It is believed that a combination of an air pocket and intrusion of sludge into the bottom of the casing caused the sludge within the casing to rise. When this was determined, the casing was resealed tightly into the clay allowing the downward sampling progression to continue.

The Phase 2 northeast pit samples were analyzed for TCL organics following extraction by modified extraction/clean-up procedures, TAL inorganics, TPH, chloride and dioxins and furans.

4.3.4.1 Northeast Disposal Pit Sludge/Clay/Scum - Organics

The volatile organic results for the northeast pit sludge/clay samples are presented in Tables 4.3-59, 4.3-60 and 4.3-61. Flash point, heat of combustion and percent ash are also presented in these tables for the Phase 1 data. Volatile TICs are presented in Tables 4.3-62, 4.3-63 and 4.3-64. Due to the oily nature and the presence of relatively high organic concentrations in the samples, the detection limits achieved for the samples are high.

Methylene chloride, acetone and 2-butanone were detected in most of the Phase 1 samples, but were also detected in associated laboratory blanks. Of these compounds, only 2-butanone was detected in a sludge and a clay sample from the north location and not detected in a corresponding lab blank. The Phase 2 data reported undetected values for both methylene chloride and 2-butanone. Acetone was detected at only 0.11 mg/kg in one sample. It is likely that the presence of these three compounds in the samples were due to laboratory impact because all three are common volatile laboratory contaminants. Chloroform was also detected in the Phase 2 sludge and clay samples. Although it is not considered a common laboratory contaminant, it was detected in at least one of the associated laboratory blanks and in some corresponding QA samples.

The sludge, scum and clay samples from the northeast pit were reported to contain benzene. The highest detected concentration for benzene occurred in the 8-11 ft duplicate sludge sample from the middle location at a value of 42 mg/kg. Toluene, ethyl benzene and xylenes were also reported in the samples. The highest detected values, 145, 80 and 325 mg/kg, respectively, occurred in the same sample as the highest benzene value. The detectable levels of these compounds were still present in the underlying clay samples but at greatly reduced values. The highest detectable value found in the clay for benzene was 9 mg/kg in the 16-17 ft clay sample at the north location.

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Various volatile TICs were also identified in the samples, the majority of which were alkanes, alkyl benzenes and unknown compounds. The concentrations of individual compounds were as high as 350J mg/kg. There was a decrease in concentrations in the clay samples, but detectable contamination was still present at values up to 61J mg/kg. The north location's 18-19 ft clay sample had no detectable volatile TICs.

The semivolatile analysis results for the northeast pit sludge/clay/scum samples are presented in Tables 4.3-65 and 4.3-66 for the Phase 1 data and Tables 4.3-67 and 4.3-68 for the Phase 2 data. The TPH results are also presented on these tables. The semivolatile TIC results are presented in Tables 4.3-69 and 4.3-70 for the Phase 1 data and Tables 4.3-71 and 4.3-72 for the Phase 2 data. As with the volatile analysis, the oily nature of the samples caused interference resulting in some elevated values and detection limits for the semivolatile compounds in the Phase 1 data. A modified extraction/clean-up procedure was used on most of the Phase 2 samples in an effort to reduce some of the interference.

A total of 13 semivolatile compounds were detected in the northeast pit. The results indicated the presence of numerous PAHs including naphthalene, 2-methylnaphthalene, fluorene, phenanthrene and pyrene. The highest reported compound in the sludge was 2-methylnaphthalene at 455 mg/kg. The highest sludge concentrations of naphthalene, fluorene, phenanthrene and pyrene were reported as 200, 61, 180 and 20J mg/kg, respectively. Detectable levels of fluoranthene and chrysene were also found. The detected compounds in the clay samples were reported at concentrations lower than the sludge samples but still relatively high especially in the 16-17 ft clay sample from the north location. This sample still reported 2-methylnaphthalene at a concentration of 382 mg/kg. At the locations where two clay samples were collected, the deeper of the two had lower levels of compounds although they were still detected.

The TPH results are reported on the semivolatile organics tables. The highest value reported was 823,000 mg/kg (82.3%). Although an analytical error was not identified, this value is suspect due to the extremely high concentration reported. The second highest value reported was 158,000 (15.8%), which is comparable to the other sludge data, for both the northeast pit and for the northwest pit. The TPH values of the clay were still relatively high, but significantly less than the sludge values. The highest TPH reported in the clay was 91,000 mg/kg.

The semivolatile TICs reported for the samples consist primarily of naphthalene isomers, alkanes and unknown hydrocarbons. The concentrations of individual compounds were as high as 4,292J mg/kg, detected in the scum sample collected during Phase 1. The size of the compounds varied up to twenty-nine carbon molecular chains. Although

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concentrations are greatly reduced, the bottom clay samples still had significant contamination. The greatest value reported in the underlying clay was 1,316J mg/kg.

The results of the northeast pit pesticide/PCB analyses are presented in Tables 4.3-73, 4.3-74 and 4.3-75. The only detectable compound in Phase 1 was Aroclor-1260, a PCB, at 5.2 mg/kg and 27 mg/kg in the upper sludge samples from the south and north locations, respectively. This compound was not detected in Phase 2. Numerous other compounds were detected in the Phase 2 analyses, however, the results are estimated due to the low concentrations reported and difficulties encountered in the quantitation of the results.

The dioxin and furan results for the investigation appear in Table 4.3-76. Each of the sludge and clay samples collected from the northeast pit during Phase 2 were analyzed for dioxins and furans. None of the samples from this pit were found to contain any 2,3,7,8-TCDD. However, detectable concentrations were reported for: 1,2,3,7,8-PeCDD (pentachlorodibenzo-p-dioxin) (0.3059J $\mu\text{g/kg}$), 1,2,3,4,6,7,8-HpCDD (heptachlorodibenzo-p-dioxin) (0.7730J, 22.0961J and 12.0435J $\mu\text{g/kg}$) and OCDD (octachlorodibenzo-p-dioxin) (3.3454J to 233.9927JE $\mu\text{g/kg}$).

The non-2,3,7,8 dioxin isomers detected were: non-2,3,7,8-TCDD, non-X,2,3,7,8-PeCDD, non-X,X,2,3,7,8-HxCDD and non-X,X,X,2,3,7,8-HpCDD. One non-2,3,7,8 furan isomer, non-2,3,7,8-TCDF, was also detected.

The toxicity equivalence to 2,3,7,8-TCDD was reported equal to or above 0.01 $\mu\text{g/kg}$ in four of the northeast pit samples. The values ranged from 0.01 to 0.45 $\mu\text{g/kg}$. The 15-16 ft clay sample was reported to have a toxicity equivalence of 0.16 $\mu\text{g/kg}$.

4.3.4.2 Northeast Disposal Pit Sludge/Clay/Scum - Inorganics

Inorganic sample results for the northeast pit sludge/clay/scum are presented in Tables 4.3-77 through 4.3-79. Chloride, total solids and pH results are also presented in these tables. Six metals were noticed at concentrations which were significantly higher in the sludge samples compared to the underlying clay and background samples. The highest values detected for each metal were: 48,400 mg/kg barium, 24,100 mg/kg calcium, 857 mg/kg chromium, 111 mg/kg copper, 585 mg/kg lead and 2,560 mg/kg zinc. Mercury was also elevated in all but two of the sludge samples. The highest value detected for mercury was 3.4 mg/kg. The scum sample produced results similar to the clay samples. It contained elevated levels of barium and zinc, but at values much less than the sludge. The scum did, however, unlike the clay, have an elevated value for mercury of 0.4 mg/kg.

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Cadmium was found to be elevated in four of the sludge samples when compared to background values and the underlying clay. Cyanide was detected in two of the sludge samples although at levels equal to the detection limit. The maximum concentrations reported for the two metals were 7 mg/kg cadmium and 2 mg/kg cyanide. Compared to background levels, the majority of the samples, including the clay samples, had elevated levels of sodium. As also indicated in the northwest pit, the clay samples appear to have a naturally high content of magnesium and manganese. Silver was detected in two clay samples at 5.3J mg/kg.

The chloride and pH analyses produced elevated values in the northeast pit. The sludge and underlying clay have maximum chloride concentrations of 33,000 and 47,000 mg/kg, respectively, as compared to the maximum reported background value of 753 mg/kg. The background soil pH ranged from 5.4 to 6.4 while the sludge pH ranged from 7.1 to 8.2 and the clay pH ranged from 6.5 to 7.3.

The sludge/clay samples from the northeast pit were screened during the Phase 1 field investigation for radiation using a hand held radiation meter. No readings above background were detected in any of the samples.

4.3.4.3 Northeast Disposal Pit Sludge/Clay/Scum - TCLP Analysis

The TCLP was run on the northeast pit sludge samples collected during Phase 1. The TCLP extract was then analyzed for TCL organic and TAL inorganic parameters. Results are presented in Tables 4.3-80 through 4.3-84. No compounds were found to exceed the TCLP regulatory level as listed in 40 CFR 261. Although elevated levels of benzene were detected, the levels did not exceed the 500 µg/l regulatory level. The results did confirm the presence of benzene, ethylbenzene, toluene, xylenes and various alkyl benzenes and cyclohexanes. The presence of 2-butanone and acetone are also indicated. The semivolatile analysis results indicate the presence of phenols, naphthalenes and various other PAHs.

4.3.5 South Disposal Pit Sludge/Sediment/Clay

During the investigations, sludge/sediment and underlying clay samples were collected from the south disposal pit. Sample locations are shown in Figure 2.3-6. Water samples were also collected and are discussed in Section 4.3.7.

Five sludge/sediment samples were collected with a S.S. dredge sampler from four different locations during Phase 1. A sludge/sediment sample and a duplicate was collected from the northeast corner of the pit. Sludge/sediment samples were also

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collected from the southwest corner, northwest corner and north-center locations. Underlying clay samples were collected with a S.S. hand auger from the northeast corner, north-center, northwest corner and southwest corner from the 0-1 ft depth range. A duplicate underlying clay sample was collected from the southwest corner at a depth of 2-2.5 ft. All Phase 1 samples were analyzed for TCL organics, TAL inorganics, TPH, cyanide and chloride. In addition, the sludge/sediment samples were analyzed for flash point, heat of combustion and they were tested by the TCLP. The TCLP extract was analyzed for TCL organics and TAL inorganics.

The Phase 2 sampling effort consisted of collecting two composite sludge/sediment samples from the bottom of the pit. Each composite sample, an east and a west, were composited from three sample locations as shown in Figure 2.3-6. The samples were collected with a stainless steel hand auger. The samples were analyzed for TCL organics following extraction by modified extraction/clean-up procedures. The samples were also analyzed for TAL inorganics, TPH, chloride and dioxins and furans.

4.3.5.1 South Disposal Pit Sludge/Sediment/Clay - Organic Analysis

The volatile organic results for the south pit sludge/sediment and clay samples are presented in Tables 4.3-85 and 4.3-86. Flash point and heat of combustion values are also presented in the volatile tables. Volatile TICs are presented in Tables 4.3-87 and 4.3-88. Due to the oily nature of the samples and the presence of relatively high organic concentrations, the detection limits achieved for the Phase 1 sludge/sediment samples are relatively high, therefore, several compounds detected in the clay samples at low levels are reported as undetected in the sludge/sediment.

Methylene chloride, acetone and 2-butanone were detected in several of the Phase 1 samples, but were also detected in associated laboratory blanks. All three of these compounds are common volatile laboratory contaminants. Acetone was also detected in the south pit water samples as described in Section 4.3.7. Acetone and 2-butanone were detected in the clay sample from the northwest corner and were not detected in the sample's associated blank. Methylene chloride, acetone and 2-butanone were all reported as undetected (< 3.0 mg/kg) in both of the Phase 2 composite sludge/sediment samples. These Phase 2 composite samples did, however, report chloroform at 0.43J and 0.36J mg/kg. Chloroform was not detected in the associated laboratory blank, but it was detected in some QA samples. Chloroform was not detected in any of the Phase 1 south pit samples.

Benzene, toluene, ethyl benzene and xylenes were detected in the south pit. The highest concentration for benzene occurred in the northwest corner sludge/sediment sample at

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7.5J mg/kg. The highest detected values for toluene and ethyl benzene occurred at the same location with numbers of 11.5J and 6.5J mg/kg, respectively. The northeast corner sludge/sediment sample reported the greatest value for xylenes at 40 mg/kg. The detectable levels of these compounds were still present in the underlying clay samples but at greatly reduced values. The highest detectable value found in the clay for benzene was 0.150 mg/kg in the northeast corner sample.

Very few volatile TICs were identified in the clay samples. The sludge/sediment samples contained various cyclohexanes, alkyl benzenes and unknown compounds. The compound with the greatest concentration was an alkyl benzene at 45J mg/kg.

The semivolatile analysis results for the south pit sludge/sediment and clay samples are presented in Table 4.3-89 and 4.3-90 with TIC results in Tables 4.3-91 and 4.3-92. The TPH results are also presented in the semivolatile tables. As with the volatile analysis, the oily nature of the samples caused interference, resulting in some elevated detection levels for the samples.

The only three semivolatile compounds detected in the Phase 1 results were 2-methylnaphthalene, 2,4-dinitrophenol and 4,6-dinitro-2-methylphenol. All three were detected in the southwest corner sludge/sediment sample at their highest concentrations of 50J, 268J and 79J mg/kg, respectively. The Phase 2 semivolatile analysis, which utilized the modified extraction/clean-up procedure, detected 2-methylnaphthalene at a high value of 26 mg/kg in the east composite sample. 2,4-dinitrophenol and 4,6-dinitro-2-methylphenol were not detected in the Phase 2 sludge/sediment samples. Six other compounds, however, were detected in the Phase 2 composite sludge/sediment samples. Four of these were naphthalene, fluorene, phenanthrene and pyrene. They were reported at their highest concentrations of 7.4J, 6.0J, 7.8J and 2.3J mg/kg, respectively, in the east composite sludge/sediment sample. There was only one semivolatile compound detected in the Phase 1 clay samples. 2-Methylnaphthalene was reported at 0.17 mg/kg in the northeast corner clay duplicate sample. None of the other clay samples reported any detectable compounds.

The TPH results for the south pit samples are reported on the semivolatile organics tables. The TPH values of the sludge/sediment ranged up to 41,600 mg/kg. The results of the TPH analysis on the clay samples showed the clay to be relatively clean. Although one sample had a TPH value of 7,140 mg/kg, the next highest value was only 5.4 mg/kg.

The semivolatile TICs reported for the samples consist primarily of naphthalene isomers, alkanes and various unidentified compounds. The concentrations of individual

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compounds in the sludge/sediment were as high as 1,353J mg/kg. Although concentrations were reduced by two orders of magnitude or more, the clay samples still had some detectable TICs. The greatest reported value in the underlying clay was 6.8JB mg/kg.

The results of the south pit sludge/sediment and clay pesticide/PCB analyses are presented in Table 4.3-93. The only pesticides detected were gamma-BHC and heptachlor at 0.038 and 0.021 mg/kg, respectively. Both were detected in the clay sample collected from the northwest corner. No other pesticides or PCBs were detected in any of the other clay or sludge/sediment samples.

The dioxin and furan results for the south pit appear in Table 4.3-94. Both Phase 2 composite sludge/sediment samples detected the same three dioxin isomers and no furans. The west composite sample had the greatest values in each case. The west sample's concentrations were 1.2837J $\mu\text{g/kg}$ 1,2,3,4,6,7,8-HpCDD (heptachlorodibenzo-p-dioxin), 1.41J $\mu\text{g/kg}$ non-X,X,X,2,3,7,8-HpCDD and 8.1979 $\mu\text{g/kg}$ OCDD (octachlorodibenzo-p-dioxin). The west composite sample was determined to have a toxicity equivalence to 2,3,7,8-TCDD of 0.02 $\mu\text{g/kg}$ while the east composite sample had a value of 0.01 $\mu\text{g/kg}$.

4.3.5.2 South Disposal Pit Sludge/Sediment/Clay - Inorganic Analysis

Inorganic sample results for the south pit sludge/sediment/clay are presented in Tables 4.3-95 and 4.3-96. Chloride, total solids and pH results are also presented in these tables. Four metals were noticed at concentrations which were significantly higher in the sludge/sediment samples compared to the underlying clay and background samples. The highest values detected for each metal were: 7,450 mg/kg barium, 16,600 mg/kg calcium, 136 mg/kg chromium and 1,510 mg/kg zinc. Mercury was also detected in one of the sludge/sediment samples at a concentration of 0.4 mg/kg.

Antimony was found to be elevated in one of the sludge/sediment samples when compared to background values and the underlying clay. It was reported at 16.9J mg/kg. Every sample, including the clay samples, had elevated levels of sodium. The greatest concentrations of sodium in the sludge/sediment and clay were 42,500 and 10,200 mg/kg, respectively. Cobalt, magnesium, manganese, nickel and potassium concentrations were elevated in one or more of the clay samples. The maximum concentrations reported for the five metals were 47.2J mg/kg cobalt, 4,710 mg/kg magnesium, 3,700J manganese, 56.1 mg/kg nickel and 3,290 mg/kg potassium. These elevated clay concentrations appear to be possibly a naturally occurring condition due to the lack of elevated levels detected in the sludge/sediment samples.

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The chloride and pH analyses revealed elevated values in the south pit. The sludge/sediment and underlying clay have maximum chloride concentrations of 66,900 and 13,700 mg/kg, respectively, as compared to the maximum reported background value of 753 mg/kg. The background soil pH ranged from 5.4 to 6.4 while the sludge/sediment pH ranged from 7.0 to 7.7 and the clay pH ranged from 6.9 to 8.0.

Sludge/sediment/clay samples from the south pit were also screened during the Phase 1 field investigation for radiation using a hand held radiation meter. No readings above background were detected in any of the samples.

4.3.5.3 South Disposal Pit Sludge/Sediment - TCLP Analysis

The TCLP was run on the sludge/sediment samples collected from the south pit during Phase 1 of the field investigation. The TCLP extract was then analyzed for TCL organic and TAL inorganic parameters. Results are presented in Tables 4.3-97 through 4.3-101. No compounds were found to exceed the TCLP regulatory levels as listed in 40 CFR 261. The results did confirm the presence of benzene, ethyl benzene, toluene, xylenes and numerous alkyl benzenes and cyclohexanes. The presence of 2-butanone and acetone are also indicated. The semivolatile analysis results indicated the presence of phenols, naphthalenes and benzoic acid.

4.3.6 Disposal Pit Edges

The Phase 2 field investigation included sampling the edges of all three disposal pits. Seven composite sludge/soil samples, two from each of the three pits plus a duplicate from the northwest pit, and two additional grab sludge/soil samples, one from each of the northwest and northeast pits, were collected from the locations shown in Figure 2.3-4. As depicted in the figure, all composite samples were compiled from three locations. The samples were collected with S.S. spoons and composited in S.S. bowls.

The disposal pit edge samples were collected from the northwest pit at the oily interface between the soil berm material and the sludge. The samples from the northeast pit were collected from the oily interface along the berm, above the waterline. The south pit samples were collected from the soil directly above the waterline.

All pit edge samples were collected from the surface to approximately 3-5 inches in depth. Each of the seven composite samples were analyzed for TCL organics, utilizing a modified extraction/clean-up procedure, TAL inorganics, TPH, chloride and dioxins and furans. The two grab samples were analyzed only for TCL organics utilizing the modified extraction/clean-up procedures. It should be noted that all TCL organic

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analyses for the pit edge samples are reported in $\mu\text{g/kg}$ whereas the disposal pit TCL organic results are reported in mg/kg .

4.3.6.1 Disposal Pit Edges - Organics

The volatile organic results for the pit edge sludge/soil samples are presented in Tables 4.3-102 and 4.3-103. The volatile TICs are presented in Tables 4.3-103 and 4.3-104.

Methylene chloride, acetone and/or 2-butanone were detected in some of the pit edge samples. All three compounds are common volatile laboratory contaminants, however none were detected in associated laboratory blanks. The greatest values at which methylene chloride, acetone and 2-butanone were detected were 101, 990J and 270 $\mu\text{g/kg}$, respectively. These values were all significantly less than what was detected within the pits. Chloroform was also detected in four samples, but it was additionally detected in the associated laboratory blanks. Therefore, the detection of chloroform is believed attributable to laboratory influence.

As detected in the pit sludge samples, benzene, toluene, ethyl benzene and xylenes were reported in the pit edge samples from the northwest and northeast pits. These four compounds, however, were detected at concentrations less than those of the sludge samples from within the pits by at least two orders of magnitude. The greatest concentrations reported in the samples were 90J $\mu\text{g/kg}$ benzene, 36J $\mu\text{g/kg}$ toluene, 140J $\mu\text{g/kg}$ ethyl benzene and 280J $\mu\text{g/kg}$ xylenes.

The detected volatile TICs were reported as either unknown compounds or unknown hydrocarbons except for a single detection of an unknown alkyl benzene. The single highest concentration of an individual compound was 1,840J $\mu\text{g/kg}$ of an unknown hydrocarbon. All reported values were considerably less than those reported for the sludge samples from within the pits. The analyses for four samples, the northeast pit grab sample, the northeast pit--south composite sample and both south pit composite samples, detected no volatile TICs.

The semivolatile analysis results of the pit edge samples are presented in Tables 4.3-105 and 4.3-106. The TPH results are also presented on these tables. The semivolatile TIC results for the pit edge samples are presented in Tables 4.3-107 and 4.3-108.

A total of 13 semivolatile compounds were detected in the pit edge sludge/soil samples. The results indicated the presence of numerous PAHs including naphthalene, 2-methylnaphthalene, fluorene and phenanthrene. The highest reported values for these four compounds, as well as eight of the other nine detected compounds, occurred in the

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northwest pit grab sample. This sample detected naphthalene, 2-methylnaphthalene, fluorene and phenanthrene at values of 615J, 4,300J, 3,300J and 5,700J $\mu\text{g/kg}$, respectively. Detectable levels of fluoranthene, pyrene and chrysene were also found as well as three phthalate compounds, which occur commonly as semivolatile laboratory contaminants. Comparably, the values of the detected semivolatile compounds are an order of magnitude or two smaller than the values detected in the pits. Only two compounds were detected in each of the two south pit edge samples while all 13 compounds were detected in the northwest pit grab sample. As a result of surrogate recoveries being less than 10%, the quantitation limits of the analysis for the northwest pit -- south composite are unusable. Peaks indicative of these compounds were not observed, however, the lowest detectable value is unknown.

The TPH results for the pit edge samples are also reported on the semivolatile tables. The highest TPH value occurred in the northeast pit--north composite sample at a concentration of 291,000 mg/kg. The lowest TPH value was detected in the south pit--west composite sample at 194 mg/kg.

The semivolatile TICs reported for the samples consist primarily of alkanes and various unidentified compounds. The two highest detected compounds were at concentrations of 7,000,000J and 1,580,000J $\mu\text{g/kg}$ and were identified as unresolved, unsaturated hydrocarbons. Both of these compounds were detected in the south pit edge samples. These two values should be viewed with caution due to the laboratory's "lumping" of numerous peaks (detectable retention times) together and reporting one large value as opposed to numerous smaller values. The quantitation is therefore estimated.

The results of the pit edge pesticide/PCB analyses are presented in Tables 4.3-109 and 4.3-110. The results from the two grab samples were validated as being unusable due to low surrogate recoveries. There were no detected compounds in the two south pit composite samples. The remaining two locations detected nine compounds with the highest concentration occurring in the northeast pit--north composite sample. This location detected endosulfan sulfate at 250PJ $\mu\text{g/kg}$.

Although an attempt was made to eliminate interferences from the oily sample matrix by utilizing a modified extraction and cleanup method, the pesticide data is provisional due to surrogate recoveries being outside of limits and difficulties with quantitation. The duplicate results from the northwest pit -- north composite produced inconsistent results since none of the detected compounds in either sample was detected in the other.

The dioxin and furan results from the pit edge sludge/soil samples appear in Table 4.3-111. Each of the composite pit edge samples were analyzed. None of the samples were

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found to contain any 2,3,7,8-TCDD. Two other dioxins and one furan compound, however, were detected in four of the seven samples. The northwest pit--north and both northeast pit composite samples detected 1,2,3,4,6,7,8-HpCDD (heptachlorodibenzo-p-dioxin) and OCDD (octachlorodibenzo-p-dioxin). The highest values occurred in the northeast pit--north composite sample with 1,2,3,4,6,7,8-HpCDD occurring at 20.2393J $\mu\text{g/kg}$ and OCDD occurring at 83.0238J $\mu\text{g/kg}$. 1,2,3,7,8-PeCDF (pentachlorodibenzofuran) was detected in the south pit--east composite sample at a concentration of 0.1444J $\mu\text{g/kg}$. The toxicity equivalence to 2,3,7,8-TCDD for the four samples ranged from 0.01 to 0.28 $\mu\text{g/kg}$, which occurred in the northeast pit--north composite sample.

4.3.6.2 Disposal Pit Edges - Inorganics

The inorganic results for the pit edge composite samples are presented in Table 4.3-112. Chloride and total solids are also shown in this table. Most of the samples detected five metals at concentrations significantly above the background conditions. The highest values detected for each metal were: 27,000 mg/kg barium, 457 mg/kg chromium, 263 mg/kg lead, 2,300 mg/kg sodium and 702 mg/kg zinc. Mercury was also elevated in all but the two south pit samples. The greatest mercury value was 0.73J mg/kg.

Cadmium, calcium and copper were also elevated in most of the samples. Their greatest detected concentrations were: 3.3J, 17,000J and 96.7 mg/kg, respectively. Selenium and silver were each detected once at slightly elevated levels with concentrations of 0.60J and 2.2B mg/kg, respectively. The metal results of the pit edge samples are comparably less than the values obtained in the respective internal pit sludge analyses.

The chloride results show that the three northwest pit edge samples reported elevated values. The maximum reported background value was 753 mg/kg whereas the maximum northwest pit edge concentration was 2,151 mg/kg. This value, however, is substantially lower than the maximum value obtained from the northwest pit sludge.

4.3.7 Disposal Pit Waters

During the Phase I field investigation, water samples were collected from the south and northeast pits. Sample locations are shown on Figure 2.2-3. Two composite samples were taken from each pit; a surface water sample, collected with a HDPE beaker, and a subsurface water sample, collected with a subsurface grab sampler. Both samples from the south pit are composites of grab samples taken from the east and west sides of the pit. Both samples from the northeast pit are composites of grab samples taken from three different locations, the southeast corner, southwestern corner and the center of the pit.

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All surface and subsurface disposal pit water samples were analyzed for TCL organics, TAL inorganics, cyanide, chloride, TOC and COD. Temperature, pH and conductivity were measured in the field.

4.3.7.1 Disposal Pit Waters - Organics

The volatile organic results for the water contained in the south and northeast disposal pits are presented in Table 4.3-113. As indicated, the analysis was performed past the technical holding time, therefore the results are estimated and may be low. Methylene chloride and tetrachloroethene were detected in one or more of the samples, however, these compounds were detected in the related laboratory blank samples, therefore, their presence is not certain. Acetone was also detected in the samples. Although it was not detected in laboratory blanks, acetone, like methylene chloride, is a common volatile laboratory contaminant. However, high levels of acetone were detected in the east storage tank, therefore its presence at the site is possible. The solvent 1,1-dichloroethane was detected in the subsurface sample from the south pit at 4J $\mu\text{g/l}$. The other volatile organics detected in both pits are common fuel constituents; benzene, ethyl benzene, toluene and xylene. Benzene had the highest concentration reported at 200J $\mu\text{g/l}$ in the subsurface south pit water sample. As a reference, the MCL for benzene is 5 $\mu\text{g/l}$.

The semivolatile analysis (Table 4.3-114) indicated the presence of several methylphenol isomers in the south pit subsurface water sample at concentrations ranging up to 95 $\mu\text{g/l}$ 2-methylphenol. Naphthalenes were detected in both subsurface water samples up to 23 $\mu\text{g/l}$. The northeast pit subsurface water sample also contained low levels (2-4J $\mu\text{g/l}$) of fluorene, phenanthrene and chrysene.

Various semivolatile TICs were also identified in the water samples (Table 4.3-115). In addition to numerous unknowns, the tentative identifications include various substituted benzenes, phenols and naphthalenes at concentrations between 7J and 35J $\mu\text{g/l}$. The highest single detected compound was an unknown reported at 64J $\mu\text{g/l}$ in the northeast pit subsurface sample.

TOC and COD values are also reported on Table 4.3-114. The disposal pit water values are substantially higher than those reported for the site ditches or the saltwater ponds indicating that the contaminants present could have an impact on water quality if discharged directly. In fact, the lowest reported values for TOC and COD in the pit waters exceed the greatest values reported for the ditch or pond samples.

The pesticide/PCB results are presented in Table 4.3-116. Several compounds were detected with the highest being 2.7J $\mu\text{g/l}$ of beta-BHC in the northeast pit subsurface

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water sample. The values reported were all estimated due to high background interference.

4.3.7.2 Disposal Pit Waters - Inorganics

The inorganic sample results for the disposal pit waters are presented in Table 4.3-117. Chloride, temperature, conductivity and pH are also shown on this table. The highest levels of inorganics were detected in the subsurface sample collected from the south pit. Possible disturbance of the underlying sediments could have contributed to the high values. This sample detected antimony, barium and chromium of concentrations of 93.3, 13,000 and 99.7 $\mu\text{g/l}$, respectively. Beryllium was the only element detected higher in a different sample. It was detected at 2.5B $\mu\text{g/l}$ in the surface sample from the northeast pit. As a reference, the MCLs for the previously mentioned metals are 2,000 $\mu\text{g/l}$ barium, and 100 $\mu\text{g/l}$ chromium (U.S. EPA, 1991). Newly promulgated MCLs for antimony and beryllium are 6 and 4 $\mu\text{g/l}$, respectively. The subsurface south pit sample also had noticeably higher concentrations, compared to the three other pit water samples for aluminum, arsenic, calcium, cobalt, copper, iron, magnesium, manganese, potassium, sodium and vanadium. The chloride and conductivity values were also much higher.

The other three pit water samples reported many elements at levels which exceed those detected in other site surface waters. The elements reported at elevated concentrations are barium, beryllium, calcium, chromium, cobalt, iron, magnesium, manganese, sodium, vanadium, zinc and chloride.

4.3.8 Disposal Pit Berms

The pit berm soils were sampled to characterize the material as contaminated or not and to assess the risks posed if contamination is present. Due to the common wall construction of the pits and the minimal volume of the two inner berms, only the outer berms were sampled. Four (4) composite samples were collected on the outside of the berms and four (4) composite samples were collected from the inside of the berms to characterize the construction material and to examine the potential impacts from past spillage. The samples were collected at the mid-height elevations of the berms from the 0-0.5 ft. depth range. The sample locations are shown in Figure 2.3-7. Samples were analyzed for TCL organics, TAL inorganics, TPH and chloride.

4.3.8.1 Disposal Pit Berms - Organics

The volatile organic results of the disposal pit berm soil samples are shown in Table 4.3-118. Acetone was the only volatile organic detected in any of the samples. Although

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not detected in the associated lab blanks, acetone is a common laboratory contaminant and its detection at the low levels reported is most likely the result of laboratory impact. There were no volatile organic TICs detected.

The only contaminants detected in the semivolatile analysis (Table 4.3-119) are phthalates. These compounds are also commonly associated as laboratory contaminants and were also detected in background soil samples.

There were many semivolatile organic TICs detected in the pit berm soil samples as shown on Tables 4.3-120 and 4.3-121. The highest concentration detected, 1,480,000 $\mu\text{g}/\text{kg}$, occurred in the sample from the inner berm of the northwest corner. This compound was identified as an "unresolved hydrocarbon complex". The second highest concentration, 7,200 $\mu\text{g}/\text{kg}$, was an "unknown" detected in the outer berm sample of the southeast corner. Many of the TICs are identified as unknown alkanes or unknown hydrocarbon indicating a potential of residual material from the pits. Various tentative identifications were made for hexadecanoic acid and octodecanoic acid, however, the presence of these materials is not suspected because both normally are associated with animal and vegetable fats and oils.

The results of the TPH analysis are shown on Table 4.3-119. Six of the nine samples showed that TPH was not detected (< 29 or $30 \text{ mg}/\text{kg}$). The inner berm sample of the northeast corner revealed a value of $29 \text{ mg}/\text{kg}$, which is right at the detection limit. A slightly higher, although not considered elevated, value of $34 \text{ mg}/\text{kg}$ was detected in the inner berm sample from the southeast corner. An elevated value of $311 \text{ mg}/\text{kg}$, however, was detected in the inner berm sample from the northwest corner. Although this value is substantially less than the TPH values from the sludge inside the pits, this value indicates that there is some residual sludge or other petroleum product on the inside of the northwest corner part of the berm. This value is supported by the number and concentration of semivolatile TICs that were also detected.

4.3.8.2 Disposal Pit Berms - Inorganics

The inorganic results for the disposal pit berm soil samples are shown in Tables 4.3-122 and 4.3-123. The data was evaluated utilizing the background soils discussion (Section 4.1.2) and the background soils summary table (Table 4.1-A) for comparison purposes. The berm results were not compared with any particular depth range of the background results. This is because of the unknown origin of the soil material comprising the berms. It is believed that the material originated from the creation of the present pits. If this were the case, the material would be a mixture resulting from the surface to depths of approximately 15 ft.

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The inorganic results for the inner pit berm soil sample of the northwest corner indicate elevated levels. Barium was detected at this location at an elevated value of 20,100 mg/kg. Cadmium, calcium, chromium, mercury and zinc concentrations are elevated only at this location at values of 1.8, 6,490, 56.0, 0.39 and 520 mg/kg, respectively. The highest reported concentration for lead among the berm samples also occurred here at a level of 93.5J mg/kg. All of these elevated metals, plus the high TPH value at this location, indicate that the inside soil of the berm in the northwest corner of the northwest pit has been impacted by site activities.

The outer berm sample from the southeast corner had five elevated metals. Antimony, barium, cobalt, lead and manganese occur at concentrations of 5.7J, 483, 29.1, 86.5J and 2,330J mg/kg, respectively. Antimony is elevated in the inner southeast, outer northeast, outer northwest and outer southwest corner samples at concentrations of 5.6J, 6.1J, 7.1J and 6.8J mg/kg, respectively. The only other two elevated metal concentrations occur in outer and inner southwest corner samples. The outer sample reported barium at a level of 541 mg/kg and the inner sample reported cobalt at 34.0 mg/kg.

The chloride and total solids results are also reported on Tables 4.3-122 and 4.3-123. There were no elevated values reported. The highest chloride value was reported for the outer northwest corner pit berm sample at a concentration of 233 mg/kg.

4.3.9 Storage Tank Contents

At the initiation of the RI investigation, four storage tanks were located on site. Three tanks were located together in a diked area between the saltwater pond and the northwest pit. These tanks were identified as the horizontal tank, middle tank and the east tank. A fourth tank, located between the northwest pond and the saltwater pond, was identified as the "tank by pond". The location of these tanks are shown on Figure 1.2-2.

During the Phase 1 field work, the tank contents were investigated to determine the quantity and type of material present. Based on the following sampling results and the physical condition of the tanks, a group of PRPs entered into an AOC with EPA to conduct an emergency removal action on the storage tanks and their contents. This activity occurred during the same time frame as the Phase 2 field investigation therefore, additional sampling and characterization of the material was not performed during Phase 2.

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4.3.9.1 Horizontal Tank

The horizontal tank had a liquid depth of 12 inches and contained approximately 750 gallons of waste material. The contents of the tank were a clear liquid and a floating scum layer. Initially, one sample was collected containing both phases. This was sent to the laboratory as a high concentration sample. The laboratory separated the sample into two phases, water miscible (water) and non-water miscible (scum or solid). Upon screening, the water phase was deemed low level and the field team was informed that additional sample volume of water would be needed for low organic analysis. The water phase was therefore resampled, for TCL organics later in the field investigation. During the resampling it was observed that the previous scum layer had basically melted from the warmer exterior temperatures and was now an oil layer on the water. As a result of the oil, the resampled water was sent to the lab as a medium concentration, oily sample. This sample has a sample I.D.# of 709-02-91. The initial samples were analyzed for TCL organics, TAL inorganics, cyanide, flashpoint, specific heat, % ash and viscosity. The resampled water was only analyzed for TCL organics.

4.3.9.1.1 *Horizontal Tank - Organics*

The organic sample results for all four of the tanks are presented in Tables 4.3-124 through 4.3-129. The results from the volatile organic analysis on the horizontal tank samples indicted the presence of blank contaminants, methylene chloride and acetone, in all of the samples. Contamination was found mainly in the solid phase of the floating scum layer which consisted of aromatics ranging in concentration from 2.0 mg/kg ethyl benzene to 11 mg/kg total xylenes. Tentatively Identified Compounds (TICs) were only detected in the solid phase of the floating scum layer which consisted mainly of aromatics and alkanes. The highest single compound detected was a methylchlorohexane with a concentration of 14J mg/kg.

The solid phase of the floating scum layer in the horizontal tank was diluted by the laboratory for high concentration semivolatile organic analysis. Elevated detection limits therefore occurred. No TCL compounds were detected above the detection limits for the floating scum layer sample. Naphthalene and 2-methylnaphthalene were detected, in the resampled liquid phase of the tank contents at concentrations of 2J and 4J, respectively. High levels of TIC compounds were detected in the liquid phase of the tank and the solid phase of the floating scum layer, consisting mainly of paraffins. The highest single compound was an unidentified alkane with a concentration of 11,000J mg/kg.

Table 4.3-132 presents the results of the analyses for flash point, specific heat, % ash and viscosity on the horizontal tank samples. The scum layer had a flashpoint of 144°F which is just above the ignitability characteristic limit of 140°F. This sample did contain

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some water, therefore it is possible that the oil phase that was present during warmer temperatures may have had a flashpoint below the regulatory limit.

4.3.9.1.2 *Horizontal Tank - Inorganics*

Inorganic results for the horizontal tank are presented in Table 4.3-130. The water and scum phases were separated by the lab and analyzed individually. Although higher in the scum sample, both phases were found to contain elevated levels of arsenic and barium. The scum sample had a barium concentration of 6,236 mg/kg and an arsenic concentration of 18.9 mg/kg. Mercury was also detected in both samples.

The horizontal tank samples were also screened in the field for radiation using a hand held radiation meter. This was done to check for potential naturally occurring radiation encountered during the past drilling operations. No readings above background were detected in any of the samples.

4.3.9.2 Middle Tank

The middle tank had a liquid depth of 12.5 inches containing approximately 880 gallons of waste material. A valve on the tank leaked, therefore, as rainwater entered the tank through open port holes, waste leaked out onto the ground in order to maintain a constant liquid level at the valve height. The contents of the tank were a clear liquid and a floating scum layer. One sample was collected from each phase, liquid (ID# 703-01-91) and floating scum layer (ID# 702-01-91). All samples were analyzed for TCL organics, TAL inorganics, cyanide, flashpoint, specific heat, % ash and viscosity. The floating scum layer was analyzed by the TCLP. The extract for the TCLP test was analyzed for TCL organic and TAL inorganic parameters. Both samples (liquid and scum) submitted for the TAL inorganic and cyanide analysis and the scum sample submitted for organic analysis further separated into two phases, water miscible (water) and non-water miscible (scum or solid) phases. Each individual phase was analyzed separately by the laboratory.

4.3.9.2.1 *Middle Tank - Organics*

Organic sample results for the middle tank samples are presented in Tables 4.3-124 through 4.3-129. Results from the volatile organic analysis indicate the presence of blank contaminants, methylene chloride and acetone, in all samples. Contamination was found mainly in the solid phase of the floating scum layer and consisted of aromatics ranging from 6 mg/kg ethyl benzene to 31 mg/kg total xylenes. TICs were only detected in the solid phase of the floating scum layer, which consisted mainly of aromatics and alkanes with concentrations up to 36J mg/kg.

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The solid phase of the floating scum layer was diluted by the laboratory for high semivolatile organic analysis. Elevated detection limits therefore occurred. No TCL compounds were detected above the detection limits for any of the samples. Various semivolatile TICs were detected in the solid phase of the floating scum layer, consisting mainly of paraffins, with concentrations up to 19,000 mg/kg. Compounds with up to 30 carbons were detected.

No pesticides or PCBs were detected in any of the middle tank samples.

Table 4.3-132 presents the results of analysis for flashpoint, specific heat, % ash and viscosity. Both the scum and the liquid sample have reported flash-point numbers above the regulatory limit of 140°F with values of 151 and 156°F, respectively.

4.3.9.2.2 Middle Tank - Inorganics

Inorganic results for the middle tank are presented in Table 4.3-130. As indicated previously, the liquid and scum phases of each sample were separated by the lab and analyzed individually. Although higher in the scum samples, both phases were found to contain elevated levels of barium. The highest being 9,824 mg/kg barium. Elevated levels of chromium, lead, mercury and zinc were also detected in the scum samples. A mercury concentration of 5.91 mg/kg was reported for one of the scum samples. The other had a mercury concentration of 1.34 mg/kg.

The middle tank samples were also screened in the field for radiation using a hand held radiation meter. No readings above background were detected in any of the samples.

4.3.9.2.3 Middle Tank - TCLP Analysis

Results of the TCLP analysis are presented in Tables 4.3-133 through 4.3-136. No compounds were found to exceed the TCLP regulatory levels as listed in 40 CFR 261. The TCL organic analysis results indicated the presence of benzene, toluene, xylenes, phenols and naphthalenes.

4.3.9.3 East Tank

The east tank had a liquid depth of 14 ft containing approximately 10,500 gallons of waste material. The contents of the tank were detected to be in two phases with the bottom phase being a clear liquid and the top phase consisting of oil. The top oil phase was estimated to be at least 3,000 gallons. No detectable layer of sludge was identified in the tank, however, during the PRP led removal action, approximately 4,000-5,000

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gallons of a thicker sludge-like material was discovered in the tank. The material was still of low enough viscosity to be pumpable, which is believed why the probing of the tank contents during Phase I did not detect this different phase. Depth discrete samples were collected from the top 1 foot (ID# 705-02-91), the middle location at 8 feet depth (ID# 706-02-91) and the bottom location at 11 feet depth (ID# 707-02-91). The middle depth sample, (ID# 706-02-91), separated into two phases, water miscible (water) and non-water miscible (oil), and were analyzed separately by the organic and inorganic laboratories. Samples were analyzed for TCL organics, TAL inorganics, cyanide, flashpoint, specific heat, % ash and viscosity.

4.3.9.3.1 East Tank - Organics

Organic sample results for the east tank samples are presented in Tables 4.3-124 through 4.3-129. Results from the volatile organic analysis indicated the presence of blank contaminants, methylene chloride and acetone, in all samples. Acetone was found in the middle and bottom depth samples at significantly greater concentrations than the levels found in the sample blanks. The highest concentration being 1,100B mg/kg in the bottom "water" sample. The highest concentration of volatile contaminants were found in the oil phase of the middle depth sample, which consisted mainly of aromatics ranging from 530 mg/kg benzene to 2,700 mg/kg total xylenes. Volatile TICs found in the samples consisted of alcohols, organic esters, straight chain hydrocarbons and aromatic compounds. The highest concentration of a TIC was a straight chain hydrocarbon at 37,000J mg/kg hexane, found in the oil phase of the middle depth sample.

The semi-volatile organic east tank samples were diluted by the laboratory for analysis due to the high levels of phenols and/or naphthalenes. Elevated detection limits therefore occurred. The highest concentration of contaminants were found in the oil phase of the middle depth sample, which consisted mainly of aromatics ranging up to 900 mg/kg 2-methylnaphthalene, organic acids ranging up to 1,200 mg/kg phenol, and polynuclear compounds ranging up to 170J mg/kg phenanthrene. TIC compounds found in the semivolatile samples consisted of mainly organic acids, alcohols, aromatics and paraffins. The highest concentration of contaminants were found in the oil phase samples.

No pesticides or PCBs were detected in any of the east tank samples.

Table 4.3-132 shows the results of the analyses for flashpoint, specific heat, percent ash and viscosity on the east tank samples. All three depth samples met the characteristic of ignitability under the Resource Conservation and Recovery Act (RCRA) guidelines for having a flash point less than 140°F.

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4.3.9.3.2 *East Tank - Inorganics*

Inorganic results for the east tank are presented in Table 4.3-131. The inorganic analysis indicated the oil phase of the middle depth sample contained the highest concentration of contaminants. Elevated levels of barium, chromium, lead and mercury were detected at 1,922, 40.5, 54.3 and 2.4 mg/kg, respectively. Zinc and magnesium were also present.

The east tank samples were also screened in the field for radiation using a hand held radiation meter. No readings above background were detected in any of the samples.

4.3.9.4 Tank By Pond

The horizontal tank located between the northwest pond and the saltwater pond is identified as the "tank by pond". This tank contained approximately 85 gallons of water material consisting of a thick sludge with a thin top layer of oil. One sample (ID# 704-01-91) was collected from the tank with a duplicate sample (ID# 708-02091) collected two days later. Both samples were analyzed for TCL organics, TAL inorganics, cyanide, flashpoint, specific heat, ash content and viscosity. The first sample collected was further analyzed by the TCLP. The extract for the TCLP test was analyzed for TCL organics and TAL inorganic parameters.

4.3.9.4.1 *Tank by Pond - Organics*

Organic sample results for the tank by pond are presented in Tables 4.3-124 through 4.3-129. Analysis from the volatile organic analysis indicated the presence of blank contaminants in both samples. The contamination detected consisted mainly of aromatics ranging from 0.6J mg/kg benzene to 37 mg/kg total xylenes. TICs were detected consisting mainly of aromatics, straight chain hydrocarbons and alkanes. The highest single compound detected was an octane at 24J mg/kg.

Both tank by pond samples were diluted by the laboratory for semivolatile organic analysis due to the high concentration of hydrocarbon contamination. Elevated detection limits therefore occurred. No TCL compounds were detected above the detection limits for either sample. Various semivolatile TICs were detected consisting mainly of paraffins, with concentrations up to 16,000J mg/kg. Compounds with up to 30 carbons were detected.

No pesticides or PCBs were detected in either tank sample.

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Table 4.30-132 presents the results of the analyses for flashpoint, specific heat, percent ash and viscosity for the tank by pond samples. Both samples reported flashpoint values greater than the RCRA regulatory guideline of 140°F.

4.3.9.4.2 Tank by Pond - Inorganics

The inorganic results for the tank by the pond are presented in Table 4.3-130. Inorganic concentrations were not similar to the other tanks. Barium, chromium, lead and zinc are present but at much lower levels. Mercury was detected in one of the samples at 0.39 mg/kg.

The tank by pond samples were also screened in the field for radiation using a hand held radiation meter. No readings above background were detected in any of the samples.

4.3.9.4.3 Tank by Pond - TCLP Analysis

Results of the TCLP analysis on the tank by pond samples are presented in Tables 4.3-133 through 4.3-136. No compounds were found to exceed the TCLP regulatory levels as listed in 40 CFR 261. The TCL organic analysis results indicated the presence of benzene, toluene, xylenes and various phenols.

4.3.10 Tank Soils

During Phase 1, a composite soil sample was collected from the soil next to the three tanks located between the saltwater pond and the northwest pit. The sample was collected by hand augering at four different locations to a depth of six inches and compositing all soils into one sample. The four locations for the sample were collected near fill or drain valves on the tanks. The locations are shown on Figure 2.3-8. This sample was analyzed for TCL organics, TAL inorganics, cyanide, TPH, pH and chloride.

During Phase 2, following the removal action on the storage tanks, a series of soil samples were collected from the diked area as shown on Figure 2.3-8. Samples were collected from areas adjacent to valve locations on the tanks, locations from under the tanks, from areas adjacent to the tanks to evaluate the extent of contamination, if detected, and from drainage paths away from the diked area. The diked area drains to the west through a pipe which directs surface runoff, including the discharge from the large pond, to the south access road ditch.

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Samples were analyzed for TCL volatile and semivolatile organics, TAL inorganics, chloride and TPH. Pesticides and PCBs were not analyzed for since detectable levels were not found in the Phase 1 samples. Dioxin and furan analysis was also included on several of the samples during Phase 2 to evaluate the presence of these compounds resulting from the potential past disposal of chemical wastes.

A single grab soil sample was also taken during Phase 2 from the area of the small tank by the northwest pond (Figure 2.3-1). During the removal action, approximately one gallon of material spilled during the physical removal of the tank. Visually contaminated soil and vegetation was removed and containerized by the tank removal contractor for eventual disposal with the tank contents. A sample was collected of the remaining surface soil to evaluate the effectiveness of the soil removal. The sample was analyzed for TCL volatiles and semivolatiles, TAL inorganics, chloride and TPH.

4.3.10.1 Tank Soils - Organics

The volatile organic results for the tank soil samples are presented in Tables 4.3-137 and 4.3-138. Methylene chloride and acetone were detected in the majority of samples as well as the associated lab blanks. The only other TCL volatiles detected were in the 2-3 ft sample collected at grid point 13S-34W. Ethyl benzene and total xylenes were detected at 1J and 12J $\mu\text{g}/\text{kg}$, respectively. The 0-1 ft sample has reported results undetected at values equal to or greater than the deeper sample. Both samples had volatile TICs detected. The 0-1 ft sample had more compounds detected and at much higher values. The highest concentration detected was for two separate compounds, both unknown hydrocarbons, each with a concentration of 1,380J $\mu\text{g}/\text{kg}$.

The results of the TCL semivolatile analysis on the tank soil samples are presented in Tables 4.3-139 through 4.3-143. In the area of the former tank battery, the only detectable semivolatiles, other than phthalates, were identified in the samples collected from the area between the horizontal tank and the middle tank, the areas north of the horizontal tank and at the south end of the horizontal tank. These areas were observed to be discolored during the investigation. The north and northeast corner of the horizontal tank received runoff from the leaked material from the middle tank. Various PAHs including phenanthrene, fluoranthene, pyrene and chrysene were detected. Levels as high as 180J $\mu\text{g}/\text{kg}$ of benzo(b)fluoranthene and/or benzo(k)fluoranthene were measured at the south end of the horizontal tank. These compounds coeluted for these samples and a total of the two compounds was reported.

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The sample collected at the location of the small tank by the pond also detected PAH contaminants, such as benzo(b)fluoranthene (210 J $\mu\text{g/kg}$), benzo(k)fluoranthene (160J $\mu\text{g/kg}$) and chrysene (150J $\mu\text{g/kg}$).

Semivolatile TICs detected in the tank soil samples are presented in Tables 4.3-144 through 4.3-148. Numerous TICs were detected in the majority of samples, however, similar to the TCL semivolatile analysis, the greatest number and concentrations were detected in the samples between the horizontal and the middle tank. TIC values remained relatively high in several of the 2-3 ft samples also. The northern samples, along the north berm, were collected in a slight drainage path that drains runoff away from the tank area to the west toward the drain pipe. This area also contained a relatively high concentration of TICs. Semivolatile TICs were detected in all of the samples but were detected at much lower concentrations away from the tanks, toward the west and the south. The samples collected from under the middle tank also reported TICs at relatively lower concentrations. Five of the samples had the volatile compound tetrachloroethane identified as a semivolatile TIC. None of these same samples had detectable volatile TICs, therefore, the presence of this compound is uncertain. This solvent has also not been previously identified as a contaminant of the tank contents or the pit sludges.

The semivolatile TICs reported for the "tank by pond" soil sample had numerous compounds, including various alkanes and a single identification of an unresolved unsaturated hydrocarbon with a concentration of 1,080,000J $\mu\text{g/kg}$. This value should be used with caution and viewed as an estimate due to the laboratory's "lumping" of numerous peaks (detectable retention times) together and reporting one large value as opposed to numerous smaller values.

TPH results, which are also presented in Tables 4.3-139 through 4.3-143, show good correlation to the semivolatile TIC results. The greatest levels were detected between the horizontal and middle tank. The "tank by pond" sample, however, did not reflect this relationship. Although the TPH value of 1,944 mg/kg is elevated, the magnitude is not proportional to the concentration of semivolatile TICs detected.

Dioxins and furans were analyzed for on select tank soil samples, those near valves or near areas of suspected higher organic concentrations. Results are presented in Tables 4.3-149 and 4.3-150. None of the samples were found to contain any 2,3,7,8-TCDD. The samples collected at grid location 10S-30W contained detectable levels of non-2,3,7,8-TCDD in both samples, 0-1 ft and 1-2 ft. The 0-1 ft sample also had a detectable level of OCDD(octachlorodibenzo-p-dioxin). One of the samples from the northern drainage path (0S-30W) had detectable levels of 1,2,3,4,6,7,8-

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HpCDD (heptachlorodibenzo-p-dioxin) and OCDD. The samples by the east valve on the east tank (14S-0W and 16S-1W) had detectable levels of 1,2,3,7,8-PeCDD (pentachlorodibenzo-p-dioxin) and OCDD. The only other detected dioxin was in the samples collected at 27S-30W, south of the middle tank. The toxicity equivalence to 2,3,7,8-TCDD was calculated at 0.01 and 0.15 $\mu\text{g/kg}$, respectively, for the drainage path sample (0S-30W) and the 1.5-2.5 ft sample near the east tank valve (16S-1W). All other samples have toxicity equivalence values less than 0.01 $\mu\text{g/kg}$.

As indicated previously, pesticides/PCBs were not detected in the Phase 1 composite tank soil sample or the tank contents samples, therefore, their analysis was not included in Phase 2.

4.3.10.2 Tank Soils - Inorganics

The results for the tank soil samples are presented in Tables 4.3-151 through 4.3-155. Due to the past construction activities of the pits and ponds and the unconfirmed natural soil conditions in the tank area (potential of cut or fill activities), the soil samples were compared to the 0-1 ft and 1-3 ft background soil samples as an indication of elevated metals.

The values detected in the sample at grid location 40S-30W, had the highest values of arsenic (30.7J mg/kg), beryllium (2.0 mg/kg), iron (55,200 mg/kg), selenium (1.2J mg/kg), silver (3.6 mg/kg) and vanadium (69.1 mg/kg) detected in the tank soils. Oddly, these were the only metals detected at elevated levels in this sample. The sample 11S-13W, near the northern valves on the middle and east tanks had the highest detected values of calcium (39,300 mg/kg), magnesium (7,500 mg/kg), mercury (0.22 mg/kg) and zinc (197 mg/kg). Elevated levels of barium and sodium were also detected in this sample. The deeper samples (1-2 ft) collected at this location also had elevated barium, calcium, magnesium, sodium and zinc. Selenium (0.71J mg/kg) and silver (2.5B mg/kg) were detected at slightly elevated levels in the deeper sample.

The highest value of cobalt (17.7 mg/kg), manganese (983 mg/kg), nickel (32.4 mg/kg) and potassium (1,830 mg/kg) were detected in the surface soil sample by the east valve on the east tank, grid location 14S-0W. Elevated levels of barium, calcium, magnesium and zinc were also detected. The deeper sample collected at 1.5-2.5 ft adjacent to this location detected barium, cobalt and magnesium at levels comparable to background. The other metals were still detected at elevated levels.

The soil sample collected from the northern drainage path along the berm, grid location 0S-71W, had the highest detected values of barium (23,500 mg/kg) and chromium (69.8

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mg/kg) in the tank battery area. Elevated levels of calcium, lead, magnesium and zinc were also detected.

The highest lead concentration detected in the tank area was 87.4J mg/kg in the sample from grid location 20S-30W. The duplicate of this sample reported a lead concentration of 20.4 mg/kg, which is comparable to background levels.

The soil sample collected from the area of the spill by the small tank located by the pond, indicated elevated calcium (3,780 mg/kg), lead (94.1 mg/kg) and zinc (59.4 mg/kg). The lead concentration was the highest lead value detected in the tank soil samples.

4.4 SOIL BORINGS

Five soil borings, designated SB-1 through SB-3, MW-8 and MW-9, were drilled during the Phase 1 field investigation to define the soil stratigraphy at the site (Figure 1.2-2). At borings SB-2, SB-3, MW-8 and MW-9 soil samples were collected at the 0-1 ft and 2-3 ft intervals. At boring SB-1 samples were collected at the 0-2 ft and the 2-4 ft intervals. This increase in the length of the interval was required to obtain sufficient volume of soil to also analyze a duplicate sample. Samples were analyzed for TCL organic and TAL inorganic parameters, cyanide, chloride, TPH and pH.

During the Phase 2 field investigation, three additional soil borings were drilled and completed as monitoring wells MW-10, MW-11 and MW-12 (Figure 3.5-2). MW-10 is an off-site upgradient location which represents background soil conditions. MW-12 is an off-site downgradient location which is far enough removed from the site to be considered as representative of background soil conditions. MW-11, on the other hand, is not being considered background, but will be considered as an "on-site" soil boring since it is located just west of the northwest pond. The sample intervals and a more detailed discussion of the results for MW-10 and MW-12 were included in the Background Soil section (Section 4.1). Therefore, the bulk of this section's discussion will be focused on the samples collected from SB-1, SB-2, SB-3, MW-8, MW-9 and MW-11. MW-11 was sampled at the 0-1 ft, 2-3 ft, 5-6 ft, 10-11 ft and 15-16 ft depths. The Phase 2 samples were analyzed for the TCL organic and TAL inorganic parameters, chloride and TPH.

4.4.1 Soil Borings - Organics

The volatile organic compounds detected in the boring soils are included in Table 4.4-1 and 4.4-2. Methylene chloride and acetone were detected in most of the samples as well

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as the laboratory blanks and are considered attributable to laboratory impacts. Chloroform was detected in the 2-3 ft sample of MW-11 at a concentration of 1J $\mu\text{g/kg}$. This value is estimated because it is reported less than the contract required detection limit (CRDL). The only other volatiles detected were TICs, trichlorofluoromethane (Freon) and tetrahydrodimethylnaphthalene. Freon was reported in both samples from SB-2 at 15J $\mu\text{g/kg}$ and 7J $\mu\text{g/kg}$ and in the 2-3 ft sample from SB-3 at 9J $\mu\text{g/kg}$. Other site samples collected provide no indication that this material is a site contaminant and it is believed that this compound originated in the laboratory. Tetrahydrodimethylnaphthalene was reported at 31J $\mu\text{g/kg}$ in the 0-1 ft sample of MW-11.

The semivolatile analysis (Tables 4.4-3 and 4.4-4) on the soil boring samples revealed three low level phthalate compounds which are common as laboratory contaminants as well as being common in urban area soils. The only other TCL semivolatile detected was phenol at 420J $\mu\text{g/kg}$ in the 0-1 ft sample from boring SB-3. This compound was undetected in the other samples although most of the samples had detection limits that were equal to or greater than 420 $\mu\text{g/kg}$.

Semivolatile organic TICs were also detected in the soil samples at levels up to 3,200BJ $\mu\text{g/kg}$ (Tables 4.4-5 through 4.4-8). Many of the compounds were also identified in laboratory blanks and their presence in the site soil is not conclusive. The levels found were similar to those detected in background soil samples, Section 4.1.1. In fact, the greatest number (28) of semivolatile TICs were reported in MW-10, a background location.

The boring soil samples were also analyzed for TPH, however, the Phase 1 data (SB-1, SB-2, SB-3, MW-8 and MW-9) has been determined to be unusable due to low matrix spike recovery. The Phase 2 data (MW-10, MW-11 and MW-12) is presented on Tables 4.4-3 and 4.4-4. The TPH values for MW-11 are generally less than or comparable to the background values of MW-10. The highest value for MW-11 occurred in the 10-11 ft sample at a concentration of 44.4 mg/kg.

No detectable levels of TCL pesticides or PCBs were found in any of the boring samples during Phase 1. During Phase 2, the samples from MW-11 detected three pesticides at trace amounts (Tables 4.4-9 and 4.4-10). Two compounds, dieldrin and 4,4'-DDE, were detected in the 0-1 ft sample at concentrations of 0.18JP and 0.667JP $\mu\text{g/kg}$, respectively, and endosulfan II was detected in the 2-3 ft sample at a concentration of 0.11PB $\mu\text{g/kg}$. Both 4,4'-DDE and endosulfan II were detected at higher concentrations at the background location MW-10. All of the detected pesticides are estimated due to the low values detected, the compound also being detected in the lab blank or difficulties

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in quantitating the result. The presence of the pesticides is possibly due to the local land use practices of grazing and agriculture/crop-dusting, as discussed in Section 4.1.1.

4.4.2 Soil Borings - Inorganics

The inorganic sample results on the boring soil samples are reported in Tables 4.4-11 through 4.4-14. Chloride, total solids and pH are also reported. Only those elements which were higher than the representative background values in Table 4.1-A are discussed.

Arsenic was elevated at a concentration of 22.4B mg/kg in the 0-1 ft sample of MW-11. Barium was noticeably elevated in the 2-4 ft sample of SB-1 at a concentration of 1,040 mg/kg. Beryllium was found to be elevated in the 2-3 ft and 10-11 ft samples of MW-11 and the 2-4 ft sample of SB-1 at concentrations of 1.70, 2.4 and 2.8 mg/kg, respectively. Cobalt was found at substantially higher values in the 2-4 ft sample of SB-1 and the 2-3 ft sample of MW-8 at values of 154 and 49.9 mg/kg, respectively. Lead was noticeably higher in the 2-4 ft sample of SB-1 at a level of 104 mg/kg. Manganese was found to be markedly elevated in the 2-4 ft sample of SB-1 at a level of 14,800J mg/kg. Mercury was elevated in the 0-1 ft samples of MW-9 and SB-2 and the 0-1 ft and 2-3 ft samples of SB-3 at concentrations of 0.48, 0.27, 1.1 and 1.6 mg/kg, respectively. Nickel was considerably elevated at 94.9 mg/kg in the 2-4 ft sample of SB-1. Calcium, iron, magnesium, potassium, sodium and zinc were also detected at slightly elevated levels in one or more of the soil borings. There are many elevated metals present, but a contaminant trend is not evident and it is difficult to ascertain how many of the elevated values are simply due to the natural varying conditions of the area.

Elevated chloride values were reported for the surficial soil boring samples of SB-2 and SB-3 at concentrations of 950J and 645J mg/kg respectively. Values of 570 mg/kg and 753 mg/kg were reported in the surface samples of MW-11 and MW-12, respectively. The elevated chloride levels are limited to the surficial soil and levels drop appreciably in the deeper samples.

4.5 GROUNDWATER

This section contains a discussion on the results of the groundwater analyses. The first part of the section focuses on the monitoring well samples while the second part of the section discusses the residential well samples.

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4.5.1 Monitoring Wells

During the Phase 1 field investigation, water samples were collected for chemical analyses from MW-8 and MW-9 along with the seven monitoring wells that had previously been installed during the 1987 expanded site inspection (ESI). During the Phase 2 field investigation, two sampling rounds were performed. The first round of sampling (Phase 2a) was identical to the Phase 1 sampling program (MW-8, MW-9 and the seven existing wells). The second round of the Phase 2 groundwater sampling program (Phase 2b) included three newly installed wells, MW-10, MW-11 and MW-12, along with the nine previously sampled wells.

During Phase 1, the samples were analyzed for TCL organics, TAL inorganics, cyanide, chloride, alkalinity, hexavalent chromium, TOC and COD. The Phase 2 samples were analyzed for TCL organics, TAL inorganics (both total and dissolved), chloride, alkalinity, TOC and TPH. The TPH analysis was added to the Phase 2 analyte list because the Phase 1 data identified some tentatively identified compounds (TICs) in the TCL organics analyses for the disposal pits and the monitoring well samples. The COD analysis was excluded in Phase 2 because Phase 1 results did not reflect elevated numbers. The cyanide and hexavalent chromium analyses were also excluded in Phase 2 because the Phase 1 data consistently reflected the lack of any detectable values. Field measurements of temperature, pH and conductivity were collected during both investigation phases.

During the Phase 1 monitoring well sampling program, it was discovered that due to the sleeve connection type construction of the existing S.S. wells, the teflon bailers available would not pass into the screened section. The well narrows down at that point and the bailer hangs up on the connection. As a result of this, six of the seven of the existing wells were purged and sampled with either the existing PVC bailers, which had been previously dedicated to each well, or with a S.S. bailer. This was not necessary for MW-1 since the water level was above the well screen and it was not necessary to lower the bailer into the screened section. MW-1 was purged and sampled with a teflon bailer as were the new wells MW-8 and MW-9. Wells MW-5 and MW-6 were purged and sampled with the existing PVC bailers. MW-3 and MW-7 were purged and sampled with a S.S. bailer and MW-2 and MW-4 were purged with the existing PVC bailer and were sampled with a S.S. bailer.

The Phase 2 sampling effort also utilized the existing dedicated PVC bailers and teflon bailers. MW-1 was purged and sampled with a teflon bailer as were all of the new (Phase 1 and 2) monitoring wells, MW-8 through MW-12. MW-2 through MW-7 were all purged with their dedicated PVC bailers and were sampled with small diameter teflon

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bailers, with one exception. During the first sampling round, the small (1 inch diameter) teflon bailer was used to both purge and sample MW-3. The purging effort was deemed too time consuming due to the small capacity of the bailer, and from that point on, it was decided that all of the old monitoring wells (ESI wells) except MW-1, would be purged with their dedicated PVC bailers and then sampled with the teflon bailer.

Prior to sampling, the wells were purged until a minimum of three well volumes were removed and the pH, temperature and conductivity measurements had stabilized. Due to a miscalculation, only a little more than one well volume was purged from MW-1 during the Phase 1 sampling effort. Temperature, pH and conductivity measurements had stabilized during the purging effort, therefore it is believed that the samples obtained were representative of aquifer conditions and were not of static water that may have been present in the well.

Groundwater samples collected from three of the monitoring wells have been used for comparison purposes as being representative of background conditions. MW-9, approximately 15 ft east of the northeast disposal pit, and MW-10, off-site approximately 725 ft east of the site's eastern property boundary, are located upgradient from the site while MW-12, off-site approximately 450 ft west of the western site boundary, is located downgradient (Figure 3.5-2). While MW-10 may be the only true background well, it appears that MW-9 and MW-12 have not had contaminant impacts from the site. The groundwater concentrations from these wells are used for a comparative evaluation of the groundwater quality of the other monitoring wells. During the analytical data study, both phases of the RI are discussed and compared, and when feasible, results from the ESI are also brought into the discussion.

4.5.1.1 Monitoring Wells - Organics

The Phase 1 volatile organic results for the groundwater sampling are presented in Table 4.5-1. None of the well samples were found to contain any detectable levels of volatile organics. Several compounds were detected at very low levels in the related QA samples. There is no indication, however, that the external impact from laboratory or field contamination responsible for the detectable levels in the QA samples, had any affect on the individual well samples. The volatile organic results for Phase 2a and 2b are shown in Tables 4.5-2 and 4.5-3, respectively. Methylene chloride, acetone and chloroform were reported in both Phase 2 sampling rounds. Methylene chloride and acetone are commonly associated as laboratory contaminants. Methylene chloride was reported in every monitoring well sample collected during Phase 2, including the QA samples and related laboratory blanks, except MW-10 during the second sampling round. Acetone and chloroform were detected only in the QA samples except for a negligible

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trace of chloroform appearing in MW-6 during round two. Benzene was reported, less than the maximum contaminant level (MCL) of 5 $\mu\text{g/l}$, in samples from Phase 2b in MW-5 and MW-7 with values of 3J $\mu\text{g/l}$ and 2J $\mu\text{g/l}$, respectively.

The Phase 1 and Phase 2 analysis did not reveal any volatile organic TICs in any of the well samples. The only volatile TICs detected were in QA samples from the Phase 2 investigation.

The semivolatile analyses for Phase 1 (Table 4.5-4) and Phase 2 (Tables 4.5-5 through 4.5-7) detected the presence of at least one of five low level phthalates in one or more of the monitoring well samples, field QA samples and/or laboratory blank samples. The phthalates, commonly associated as laboratory contaminants, had detectable concentrations ranging from 1J to 113BJ $\mu\text{g/l}$. Due to the fact that they are common laboratory induced contaminants and their presence was also identified in the QA samples, it is suspected that the presence of the phthalates were due to external impacts from the laboratory.

There were only four other TCL semivolatile organic compounds detected, all at levels below the CLP required quantitation limit, throughout the entire monitoring well sampling program. Phenol and 2-Chlorophenol were detected at 2J $\mu\text{g/l}$ and 1J $\mu\text{g/l}$, respectively, in the Phase 1 sample from MW-3. Bis(2-Chloroethyl)Ether was detected at 1J $\mu\text{g/l}$ in the Phase 2b sample from MW-5. Phenol and 4-chloro-3-methylphenol were each detected at 1J $\mu\text{g/l}$ in the Phase 2b sample from MW-7.

The TOC and COD values for Phase 1 are reported on Table 4.5-4. The results for well MW-1 are slightly higher than the other wells, with a maximum TOC of 6.3 mg/l and a maximum COD and 54J mg/l. The TPH and TOC values for the monitoring well samples during Phase 2 are presented in Tables 4.5-5 through 4.5-7. The TPH values ranged from 0.55 to 1.35 mg/l in the first sampling round and were all undetected (<0.5 mg/l) in the second sampling round. The TOC values ranged from 4.22 to 33.2 mg/l in the first sampling round and from 13.9 to 25.5 mg/l in the second sampling round. None of the analysis revealed clear evidence of any trending values. Based on the relatively similar values reported, an obvious indication of contamination is not present. The values are also within LDEQ's normal requirements for surface discharge; 100 mg/l COD and 50 mg/l TOC.

Various semivolatile TICs were identified in the well samples during Phase 1. As indicated in Tables 4.5-8 and 4.5-9, wells MW-5, MW-6 and MW-7 had the least amount of TICs identified (one in each MW-5 and MW-6) with wells MW-1, MW-2 and MW-3 having the greatest number (15 in MW-1). The highest concentrations of any

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individual TICs were detected at MW-5 and MW-9 (540JN and 1,500JN $\mu\text{g/l}$, respectively). There were also four or more TICs reported in each of the field blank and equipment and sand rinsate samples. The parameters identified are tentative and the actual identification is unknown. The samples from wells MW-3 and MW-9 had 1,1,2,2 - tetrachloroethane identified, however, this compound is a TCL volatile parameter and was reported as undetected in the volatile analysis.

One or more semivolatile TICs were detected in all of the groundwater samples submitted for analysis in Phase 2 (Tables 4.5-10 through 4.5-13). The total number of TICs for the Phase 2a samples ranged from one in several of the wells to 20 in MW-6. The total number for the Phase 2b samples ranged from three in several wells to 18 in MW-5. MW-6, for this second sampling round, had only four TICs identified and two of those were also detected in the laboratory blank. TICs were also reported in the background wells and in the associated field QA samples. This inconsistent detection of TICs from one sampling event to the next currently provides no indication that their presence is attributable to the past site activities and contamination in the aquifer.

No detectable levels of TCL pesticides or PCBs were found in any of the well samples during Phase 1 (Table 4.5-14). The analytical results for the TCL pesticides/PCB analysis for Phase 2 are presented on Tables 4.5-15 through 4.5-17. A total of seven analytes were detected at some trace amount. None of the detected pesticide concentrations exceed the MCLs for those constituents as established under the Safe Drinking Water Act. Many of the detected pesticide concentrations are at least one order of magnitude smaller than their MCL. No PCB compounds were detected in any of the samples collected from the monitoring wells during the Phase 2 investigation.

4.5.1.2 Monitoring Wells - Inorganics

The RI analytical results for the inorganic analyses on the monitoring well groundwater samples are presented on Tables 4.5-18 through 4.5-37. Tables 4.5-18 and 4.5-19 present the results of the Phase 1 investigation. The results of the first sampling round of Phase 2 (Phase 2a) are presented on Tables 4.5-20 through 4.5-22, and Tables 4.5-23 through 4.5-27 present the results from the second sampling round of Phase 2 (Phase 2b). Tables 4.5-28 through 4.5-37 are retabulations of the previously presented inorganic data, however, instead of showing the data by the phase or sampling round, these additional tables show the data by monitoring well. This was done so that any individual well could easily be evaluated as to changing conditions over the period of study.

The results were evaluated by comparing them with potential background conditions at wells MW-9, MW-10 and MW-12. An analyte from a particular well was considered

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"elevated" if its value is greater than the largest value of the three background wells. Comparisons were also made with the MCLs set forth by the EPA [40 CFR 141.2(C)] and published in the November 1991 Drinking Water Regulations and Health Advisory. Recently promulgated MCLs (57 FR 31776; July 17, 1992) have also been included in this evaluation although they are not in effect until January 17, 1994.

Three inorganic analytes have been detected in the site monitoring wells at concentrations above their currently regulated MCLs during both the ESI and RI sampling efforts. Elevated levels of cadmium, chromium and lead were detected in at least one sample during the investigations. Three (3) additional metals; antimony, beryllium and nickel were detected above newly promulgated MCLs or the reported detection limits were above the MCLs. The exceedance of the analytes above their respective MCLs are summarized in Table 4.5-A (included within text), which shows their total metals concentrations.

Although the ESI results reported exceeding values of total cadmium (MCL = 5 ug/l) in all seven of the sampled wells (MW-1 through MW-7), Table 4.5-A shows that none of the 12 site monitoring wells exhibited any values exceeding the MCL for cadmium during the three sampling rounds of the RI. Additionally, only one RI sample, MW-11 collected during Phase 2b, reported an elevated value, 3.1B $\mu\text{g/l}$. This is compared to the highest background concentration of cadmium, reported at 2.6J $\mu\text{g/l}$ in MW-10 during Phase 2b.

Chromium was detected in an unfiltered sample from the off-site, upgradient background well (MW-10) at a concentration of 82.8 $\mu\text{g/l}$, which is near chromium's MCL of 100 $\mu\text{g/l}$. Elevated levels of total chromium were detected in at least one sample from each of MW-2, MW-3, MW-4, MW-6, MW-7, MW-8 and MW-11 (Tables 4.5-28 through 4.5-37). Table 4.5-A shows that all of these monitoring wells except MW-11 had total chromium concentrations which exceeded the chromium MCL. MW-2 and MW-7 exhibited the highest values at 1,330 and 750 $\mu\text{g/l}$, respectively. The ESI report detected its highest level of chromium in MW-7 with a value of 229 $\mu\text{g/l}$. Results for MW-6 also exceeded the chromium MCL during the ESI with a concentration of 149 $\mu\text{g/l}$. MW-2 had reported values of 22 $\mu\text{g/l}$ and 91 $\mu\text{g/l}$.

TABLE 4.5-A
MONITORING WELLS EXCEEDING MAXIMUM CONTAMINANT
LEVELS (MCLs)
TOTAL METALS
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Monitoring Wells	Sampling Phase	Cadmium (5 µg/l) ¹	Chromium (100 µg/l) ¹	Lead (15 µg/l) ²	Antimony 6 µg/l ³	Beryllium 4 µg/l ³	Nickel 100 µg/l ³
MW-1	ESI-1	--	--	--	25 U	--	--
	ESI-2	13	--	--	60 U	--	--
	Phase 1	--	--	--	30 UJ	--	--
	Phase 2a	--	--	--	39 U	--	--
	Phase 2b	--	--	--	15.2 J	--	--
MW-2	ESI-1	--	--	--	25 U	--	--
	ESI-2	76	--	18.2 J	60 U	--	--
	Phase 1	--	--	--	36 U	--	486
	Phase 2a	--	1,330	--	39 U	--	521
	Phase 2b	--	398	--	13 U	--	348
MW-3	ESI-1	--	--	17	25 U	--	--
	ESI-2	20	--	--	60 U	--	--
	Phase 1	--	--	--	30 UJ	--	418 J
	Phase 2a	--	415	--	39 U	--	378
	Phase 2b	--	364	--	13 U	--	361
MW-4	ESI-1	6.7	--	29	25 U	4.1	--
	ESI-2	16	--	20.9 J	60 U	--	--
	Phase 1	--	--	--	30 UJ	--	525 J
	Phase 2a	--	632	--	39 U	--	575
	Phase 2b	--	118	--	13 U	--	424
MW-5	ESI-1	--	--	20 J	50 J	--	--
	ESI-2	22	--	--	60 U	--	--
	Phase 1	--	--	--	30 UJ	--	--
	Phase 2a	--	--	--	39 U	--	--
	Phase 2b	--	--	18.7	13 UJ	--	--

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reported antimony as undetected (13.0U $\mu\text{g/l}$). Antimony concentrations reported for MW-5 and MW-7 during the RI were all below detection.

The presence of antimony in the groundwater samples above natural levels is unconfirmed due to its inconsistent detection. The antimony in MW-1 was not detected in the first four samples collected (two from the ESI, Phase 1 and Phase 2a) and then it was detected at 15.2J $\mu\text{g/l}$ in the Phase 2b sample. On the other hand, the antimony detected in MW-5 was detected at 50J $\mu\text{g/l}$ in the ESI first sampling round but was not detected in the four subsequent sampling rounds. The antimony in MW-7 was only detected in the second sample of the ESI.

Beryllium was detected at 4.2B $\mu\text{g/l}$ in the off-site, upgradient background well, MW-10, in the total metals analysis. Beryllium was found in two of the 12 site monitoring wells at values greater than background. The two elevated concentrations were detected in MW-8 and MW-6 at 9.0 and 6.5 $\mu\text{g/l}$, respectively. The newly promulgated MCL for beryllium is 4.0 mg/l . As stated with the other analytes, the presence of beryllium was only detected in the total metals analysis. The dissolved inorganics analysis did not detect (<2.0 $\mu\text{g/l}$) beryllium in any of the monitoring well samples (Tables 4.5-28 through 4.5-37). The elevated values again appear to be due to the suspended solids content.

The background well, MW-10, contained total nickel at 124 $\mu\text{g/l}$. Total nickel was detected at elevated concentrations in MW-2, MW-3, MW-4, MW-6, MW-7 and MW-8 (Tables 4.5-28 through 4.5-37). The two highest total concentrations occurred in MW-6 and MW-4 with values of 659 and 575 $\mu\text{g/l}$, respectively. The newly promulgated MCL for nickel is 100 $\mu\text{g/l}$. The nickel in the background sample (MW-10) was undetected at 7.0U $\mu\text{g/l}$ when filtered. Unlike other analytes previously discussed, nickel was not reduced below detection in many of the wells when the samples were filtered, although the detected values were reduced. Elevated dissolved nickel was detected in at least one sample from MW-2, MW-3, MW-4, MW-6 and MW-7. The highest dissolved concentration occurred in MW-4 with a value of 317 $\mu\text{g/l}$.

Although, from Tables 4.5-28 through 4.5-37, it appears that the site groundwater has high concentrations of aluminum, iron and manganese, the representative background wells also have very high concentrations. The background well, MW-10, has total/dissolved concentrations for aluminum, iron and manganese of 31,300J/109J $\mu\text{g/l}$, 48,000/117 $\mu\text{g/l}$ and 1,970/439 $\mu\text{g/l}$, respectively. As evident from the reported values, the concentration of these three metals are significantly reduced in the filtered sample which reinforces, the idea that elevated metal concentrations are due in part to a large amount of suspended solids in the sampled groundwater.

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Aluminum concentrations were generally measured the highest in Phase 2a, with the greatest concentration in MW-8 at 53,400 $\mu\text{g/l}$. MW-6 had the second highest measurement at 47,400 $\mu\text{g/l}$. Values for both wells fell considerably in Phase 2b with values of 9,570J $\mu\text{g/l}$ and 7,990J $\mu\text{g/l}$ being reported for MW-8 and MW-6, respectively. The lowest values were consistently measured in MW-1.

Iron and manganese also were generally measured the highest in Phase 2a with the highest values again reported for MW-8 and MW-6. As with aluminum, concentrations of both metals dropped significantly in Phase 2b.

Barium, a potential site contaminant, was measured at its highest concentration in the upgradient, off-site background well, MW-10. Data from Phase 2b indicated a concentration of 1,180 $\mu\text{g/l}$. The MCL for barium is 2,000 $\mu\text{g/l}$. Dissolved barium was detected in the background at a concentration of 297J $\mu\text{g/l}$. The only elevated dissolved barium on-site occurred in MW-2 during Phase 2a and 2b with 343J and 435J $\mu\text{g/l}$, respectively (Table 4.5-29) and in MW-6 during Phase 2b with 302J $\mu\text{g/l}$ (Table 4.5-33). It should be noted that the values for Phase 2b are biased high for barium and are therefore estimated values.

Sodium was present at elevated levels in all monitoring wells sampled during the ESI. The ESI reported higher concentrations during their two sampling rounds than the RI's three rounds. The range of elevated values for the ESI was from 89,400 $\mu\text{g/l}$ in MW-7 to 172,000 $\mu\text{g/l}$ in MW-1.

The highest concentration of total sodium found during the RI was 148,000 $\mu\text{g/l}$ also in MW-1 during the Phase 1 sampling. Levels decreased to 87,200J $\mu\text{g/l}$ sodium in Phase 2b. From Tables 4.5-28 through 4.5-37, there seems to be a trend of increasing total concentrations with time for MW-2, MW-4, MW-5, MW-6 and MW-8 during the RI investigation. Levels in MW-3 and MW-7 stayed about the same throughout the three sampling rounds. In Phase 2b, MW-6 had the highest measured sodium concentration at 112,000J $\mu\text{g/l}$.

Arsenic was detected, but at levels less than its MCL of 50 $\mu\text{g/l}$ in MW-1, MW-2, MW-4, MW-5, MW-8, MW-11 and MW-12. Tables 4.5-28 through 4.5-37 show that the maximum arsenic concentration detected on site is at MW-1 with a total concentration of 10.7 $\mu\text{g/l}$. There does not appear to be a definite plume or downgradient trend as MW-6, a downgradient well, shows arsenic as undetected.

Mercury was detected in MW-3 at 1.9 $\mu\text{g/l}$ during Phase 1. This value is below the MCL set at 2 $\mu\text{g/l}$. The background concentration in MW-10 was measured at 0.3 $\mu\text{g/l}$.

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As evident from Tables 4.5-28 through 4.5-37, trace mercury showed up at the background level or 0.1 $\mu\text{g/l}$ above it in MW-1, MW-2, MW-4, MW-7 and MW-8 during the Phase 2 investigation. The ESI sampling indicated that mercury was below the detection limit of 0.2 $\mu\text{g/l}$.

A variety of inorganic analytes were found to be elevated in one or more wells. Potassium was elevated in MW-6 and MW-8. Vanadium was elevated in MW-8 and MW-11. Selenium was elevated in MW-2, MW-3, MW-9 and MW-11. Cobalt was elevated in MW-2, MW-4, MW-6 and MW-7. Calcium was found to be elevated in MW-1, MW-2, MW-5, MW-6 and MW-11. Magnesium was elevated in MW-1, MW-2, MW-5 through MW-8 and MW-11. Zinc was elevated in MW-1, MW-3, MW-4, MW-6, MW-8 and MW-9.

Two previous studies, the ESI performed in 1988 and an independent study performed on behalf of some area residents in 1982, evaluated the chloride concentrations in the groundwater at the site to determine possible contamination plumes. Both studies utilized terrain conductivity/resistivity geophysical methods (surveys) which can produce indications of elevated levels of inorganic constituents in the subsurface. The most common indicator parameter for these methods is the presence or lack of the chloride ion. The indirect results provided by these two dated studies indicate the presence of conductive groundwater plumes (high in chloride) radiating to the south and west from the disposal pits.

The RI results, which represent direct, current results of the groundwater conditions at the site, do not indicate high conductance/chloride groundwater contaminant plumes to the south and west. A total of 29 on-site and/or downgradient groundwater samples were analyzed for chloride content and conductivity over three sampling phases. Only four samples were reported to have chloride at concentrations above its, aesthetically based, secondary maximum contaminant level (SMCL) of 250 mg/l; MW-1 had 290J mg/l, MW-2 had 308 and 294 mg/l and MW-6 had 275 mg/l of chloride. MW-5 and MW-11 also showed elevated concentrations of chloride. The background monitoring well MW-10 reported a chloride concentration of 78 mg/l.

In general, the higher chloride concentrations occurred along the northern and western sides of the site (MW-1, MW-2, MW-5, MW-6 and MW-11). Outside of this generality there are not noticeable trends. In fact, the values for some monitoring wells appear to be sporadic. The groundwater from MW-6, for example, was analyzed three times for chloride content during the RI and produced significantly different values each time. The Phase 1 sample produced a value of 130J mg/l while the two sampling rounds from Phase 2 (a and b) produced concentrations of 275 and 62J mg/l, respectively.

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Alkalinity values were found to be higher than background ($187 \mu\text{g/l}$) in MW-1, MW-4, MW-5, MW-7, MW-8 and MW-9, however, large variations are not present. As would be expected, the field measured conductivity had a positive correlation with the alkalinity and sodium concentrations just as it did for the chloride concentrations (Tables 4.5-28 through 4.5-37). If the alkalinity or sodium concentration increased from one sampling round to the next then the conductivity was generally observed to increase also.

The one parameter of potential concern was indicated in the results from the QA samples collected during the well sampling. Mercury was reported at $1.3 \mu\text{g/l}$ for the pre-rinsate sample during Phase 1. This sample was a rinsate of the teflon bailers to be utilized during the Phase 1 sampling. The only well sample having a reported mercury level was well MW-3. As a result of the narrow construction of the existing wells a teflon bailer was not used on MW-3, instead a stainless steel bailer was used. This stainless steel bailer was used on several wells prior to well MW-3 and mercury was not detected. There is therefore no indication that the two mercury values reported are related in any way.

There is also no indication that any other parameters detected in one or more of the QA samples during Phase 1 or Phase 2 (aluminum, barium, cadmium, calcium, copper, lead, manganese, mercury, potassium, sodium, thallium and zinc) had any significant impact on the results of the well sampling. The barium levels detected in the Phase 2b bailer rinsates, sand rinsate and field blank have been attributed to laboratory error. Review of the data has indicated that the barium analysis is biased high, therefore the detected values are estimated and a potential adverse impact on the samples collected is not present.

4.5.2 Residential Wells

Ten residential wells (Figure 2.5-1), were sampled during the Phase 2 investigation. There were no Phase 1 residential well samples collected. The well samples were analyzed for TCL organics, TAL inorganics, chloride, alkalinity, TPH and TOC. The temperature, pH and conductivity of the samples were measured in the field.

Prior to sampling, the wells were purged a volume which surpassed the greater of either the well's holding tank or three times the well's volume.

4.5.2.1 Residential Wells - Organics

The results of the volatile organic analyses for the 10 residential water supply samples are presented on Table 4.5-38. Methylene chloride, a common laboratory contaminant,

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was detected in every sample including the three QA samples. Chloroform and toluene were detected only in QA samples. The results for some compounds (acetone, 2-butanone and 2-hexanone) have been qualified as unusable (R) due to laboratory QA/QC protocols.

The results for the semivolatile organic compounds are shown on Tables 4.5-39 and 4.5-40. One of four phthalate compounds, which are common semivolatile laboratory contaminants, were found in small quantities (0.5J to 6 $\mu\text{g/l}$) in seven of the ten residential well samples. One or more of ten semivolatile organic TICs were detected in six of the ten wells. Only two of the six wells had more than one TIC detected. The (b) (6) well had two TICs detected totalling 7J $\mu\text{g/l}$ and the (b) (6) well had three TICs detected totalling 48J $\mu\text{g/l}$, however, 31J $\mu\text{g/l}$ of this total was identified as a laboratory artifact.

The TPH and TOC results for the residential well samples are also shown on Tables 4.5-39 and 4.5-40. The TPH was undetected ($<0.5 \text{ mg/l}$) in all of the samples. The TOC concentrations ranged from 5.99 mg/l in the (b) (6) well to 25.9 mg/l in the (b) (6) well. This range of TOC values is consistent with the range of values from the site monitoring well samples.

The analytical results for the TCL pesticides/PCBs analysis for the ten residential water supply samples are shown on Table 4.5-41. As indicated, five of the ten wells show a trace amount of one or more of six detected pesticides. All of the detected values are at least two orders of magnitude smaller than any of their listed pesticide MCLs. Due to the low reported values and difficulties with achieving quantitation criteria, the values are all estimated. No PCBs compounds were detected in the residential well samples.

4.5.2.2 Residential Wells - Inorganics

The results of the total metals analyses on the residential groundwater samples are presented in Tables 4.5-42 and 4.5-43. The most noticeable result is the elevated arsenic concentrations present in many of the residential wells. Arsenic was detected at 2.0 $\mu\text{g/l}$ or greater in every residential well. The two highest concentrations were found in the (b) (6) and (b) (6) wells at levels of 30.5 and 21.3 $\mu\text{g/l}$, respectively. These two elevated concentrations are below the MCL for arsenic of 50 $\mu\text{g/l}$.

The source of these elevated arsenic levels is unknown. It appears that the elevated values are not related to past operations at the site. The site's two highest concentrations of total arsenic occur at MW-1 and MW-8 with values of 10.7 and 8.2J $\mu\text{g/l}$, respectively. The two residential wells with the highest arsenic concentrations are

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located south-southwest of the site which is not in a down-gradient position. Even with the theoretical event of a southern gradient, the three monitoring wells, MW-3, MW-7 and MW-11, located on the southern and western boundaries of the site, indicate that arsenic is not migrating from the site with comparable levels. These three wells, MW-3, MW-7 and MW-11, were reported with two undetected arsenic concentrations and a 6.5B $\mu\text{g/l}$ concentration, respectively.

It appears that the majority of the elevated arsenic values occur in residential wells to the south, southwest and due west of the site. There is a northwesterly trend of decreasing arsenic concentrations which proceed as follows: from the (b) (6) well (30.5 $\mu\text{g/l}$) to the (b) (6) well (21.3 $\mu\text{g/l}$) to the (b) (6) well (18.0 $\mu\text{g/l}$) to the (b) (6) well (11.6 $\mu\text{g/l}$) to the (b) (6) well (2.2 $\mu\text{g/l}$). The pattern or trend ends there, however, located immediately north of the (b) (6) well, approximately 440 ft, is the (b) (6) well which has an arsenic concentration of 20.2J $\mu\text{g/l}$.

Iron and manganese occur at concentrations above their respective SMCLs of 300 and 50 $\mu\text{g/l}$, respectively, in all of the residential well samples except the (b) (6) well, which has an iron concentration of only 35.2B $\mu\text{g/l}$. The two highest iron concentrations occur at wells (b) (6) and (b) (6) with values of 2,460 and 2,340 $\mu\text{g/l}$, respectively. The two highest manganese concentrations, 777J and 692 $\mu\text{g/l}$, occur at wells (b) (6) and (b) (6), respectively.

All the residential wells sampled had barium below the established MCL of 2000 $\mu\text{g/l}$. The highest concentration detected occurred in the (b) (6) well at 169 $\mu\text{g/l}$. The next two highest values were detected in the (b) (6) and the (b) (6) wells at 141 and 140J $\mu\text{g/l}$ respectively. These three wells are located northwest (downgradient) of the site. A level of 136 $\mu\text{g/l}$, however, was detected in the (b) (6) well, which is located south-southwest of the site. Therefore, a correlation relating the higher values found downgradient to site activities is not conclusive.

The results for magnesium, calcium, sodium, chloride alkalinity and conductivity do not indicate any individual residential well or area of wells having a significant difference in concentrations over the other wells. The only noticeable value that does not appear "normal" is the alkalinity result of 2.0U mg/l in the duplicate sample collected from the (b) (6) well. A value of 288 mg/l reported for the corresponding sample is in-line with the other residential well data.

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4.6 QA SAMPLES

During the field investigation, various QA samples, in the form of rinsates, field blanks and trip blanks, were collected to evaluate any possible external impacts to the samples collected. In most cases, the volatile bottles of a field blank also doubled as a trip blank. Samples were analyzed for TCL organics, TAL inorganics and cyanide. Trip blanks were only analyzed for volatile TCL organics. The QA samples collected during the groundwater sampling are presented in Section 4.5. Field blank results are also included in Section 4.5.

4.6.1 QA Samples - Organics

The results of the volatile organic analysis on the QA samples are presented in Table 4.6-1 for the Phase 1 samples and Table 4.6-5 for the Phase 2 samples. Common laboratory blank contaminants, methylene chloride and acetone, were detected in several of the Phase 1 and Phase 2 samples at very low concentrations. Chloroform was also detected at low concentration in both phases of QA samples. Benzene, tetrachloroethene, toluene and total xylenes were detected at very low concentrations during the Phase 1 sampling. These contaminants were detected in many of the collected samples but at much higher concentrations, therefore the external impact that may have affected the QA sample would be negligible. There is no evidence to suggest that these impacts would cause the concentrations in the site specific media samples to be higher than those seen in the QA samples.

Semivolatile organic results are presented in Tables 4.6-2, 4.6-6 and 4.6-7. The only TCL semivolatiles detected in the Phase 1 results were low levels of phthalates. These compounds are common laboratory contaminants. In addition to phthalates being detected in the Phase 2 samples, the semivolatiles, 4-nitrophenol, pentachlorophenol and pyrene, were detected in one of the hand auger rinsates collected during the sampling of the tank soils (ID# 818-10-91). A review of the tank soil data, Section 4.3.10, indicates that 4-nitrophenol was not detected in the soil samples. Pentachlorophenol was detected only once, in a sample collected several samples after the collection of the rinsate sample, and pyrene was detected in three tank area samples. All 4-nitrophenol was also detected in one of the CME sampler rinsate samples collected, however, this compound was not detected in any of the boring samples collected.

Various TICs, many of which were also detected in the laboratory blanks, were detected in the QA samples. These organic compounds that were detected are not suspected to have had an impact on the collected samples. Indications of contamination are not being based on similar levels of TIC compounds found in site media.

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Pesticides or PCBs were not detected in any of the QA samples during Phase 1. Results from Phase 2 are presented in Table 4.6-8. Only three compounds were detected, each in a different sample. The values reported are estimated due to the low detected concentration and difficulty in quantifying the results.

4.6.2 QA Samples - Inorganics

The results of the inorganic analyses for the QA samples are presented in Tables 4.6-3, 4.6-4, 4.6-9 and 4.6-10. The majority of detected inorganics were detected below the CRDLs. The main parameter and concentration that raised suspicion is the sodium value of 307,000 $\mu\text{g/l}$ from the casing rinsate during Phase 1. This sample was reanalyzed by the laboratory and similar results were obtained. The source of the sodium is unknown. This casing was installed at well MW-8 and MW-9 and a review of the inorganic data in Section 4.5 indicates sodium levels much lower than the rinsate. The sodium values reported for wells MW-8 and MW-9 were actually among the lowest sodium levels of all the wells. Although the source of the elevated sodium is unknown there is no indication that the casing has impacted the groundwater results.

The barium levels reported for three of the hand auger rinsates on Table 4.6-10 (ID #818-10-91, #820-10-91 and #821-10-91) are believed attributable to laboratory influence. Review of the data has indicated that the barium analysis was biased high, therefore the detected values are estimated and a potential impact on soil samples collected is not likely.

An elevated barium level is also reported for sample ID #814-10-91, which is a hand auger rinsate collected during the sampling of the clay beneath the northeast pit. Barium was the only metal detected, and although elevated compared to other rinsate samples, an impact to the high concentrations detected in the clay samples is not evident.

4.7 AIR

During the 1987 ESIs conducted at the PAB Oil facility and the nearby Gulf Coast Vacuum Site, Ecology and Environment, Inc. collected various air quality samples from each site. Air monitoring instrumentation was installed at 11 on-site locations on the PAB Oil property to determine the presence of the site's airborne contaminants and if present, their migratory paths off-site. The ESI report for the Gulf Coast Vacuum Services, Inc. Superfund Site (a site with a similar history, physical characteristics and contaminants of concern) stated that an interrelation existed between the contaminants detected in the two sites' trip blanks and that several imperfections were noticed in the laboratory procedures utilized to analyze the Gulf Coast air samples. The ESI data

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review for the PAB air samples did not address the issues included in the Gulf Coast report, although, the same conditions are assumed to apply since the PAB sampling occurred the day after the Gulf Coast sampling. The majority of the detected contaminants at the PAB facility were at low concentrations and were believed to be attributable to laboratory contamination (acetone, freon, 1,1,1-trichloroethane). Due to possible flaws in the procedures utilized for analysis and possible laboratory induced contaminants, the use of the positive data is limited, however, the data indicated that high levels of contaminants were not present.

The air quality of the site was also monitored during the field activities of the RI. The monitoring was performed with an OVA and/or a HNU as part of routine health and safety procedures. Readings were obtained above background at some point sources (i.g., down the sampling casings of the disposal pit sludges). No readings, however, were detected above background levels in the breathing zone during any of the site activities. The only exception to this occurred when the former east storage tank contents were sampled (discussed in greater detail in Section 2.3.7). As indicated in Section 2.3.7, the four site storage tanks and their contents have been removed from the site.

The U.S. EPA, assisted by Radian Corporation, performed trial excavations on three disposal pits which are comparable to the PAB disposal pits, at the Gulf Coast Vacuum Services, Inc. Superfund Site. Chemical contaminants identified in the pits are similar to the sludge in the pits at PAB Oil and the concentrations of organics, including volatiles, are actually higher at the Gulf Coast facility. These trial excavations were performed to provide information regarding the potential emission of volatile organic compounds which may result from this type of disturbance to the pits (Eklund, 1992). The data collected from the investigation, conducted in August of 1991 at Gulf Coast, indicated that the pilot-scale excavation activities did not result in high levels of contaminants in the ambient air (Eklund, 1992). The best conservative estimate of emissions from excavation activities at the site are:

- Benzene - $0.01 \mu\text{g}/\text{m}^2\text{-sec}$;
- Toluene - $0.005 \mu\text{g}/\text{m}^2\text{-sec}$; and
- Xylenes - $0.003 \mu\text{g}/\text{m}^2\text{-sec}$ (Eklund, 1992).

Due to the similarities between the PAB and Gulf Coast Superfund sites, it is believed that comparable, low ambient air contaminant levels would result if excavations were performed on the PAB disposal pits.

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5.0 CONTAMINANT FATE AND TRANSPORT

5.1 POTENTIAL ROUTES OF MIGRATION

Three potential contaminant migration routes were identified at the PAB site; air, surface water and groundwater. All of the contaminants which were identified at the site are included in the analytical data tables presented in Appendix II. The nature of contamination at the site, reflected by the analytical data, is discussed in detail by media and contaminant sources in Section 4.0.

5.1.1 Air

The air pathway for contaminant migration is believed to be inapplicable at the PAB site. Based on information obtained from the ESI and during the RI, there appears to be no significant levels of contaminants in the air (discussed in detail in Section 4.7). Since air does not appear to be a migration pathway, it is not further discussed in Section 5.2, Contaminant Migration.

5.1.2 Surface Water

The surface water pathway is considered to be a potential route of contaminant migration. Several site-related contaminants appear to be migrating off-site via the site's surface water drainage system. It is believed that all overflow/excess water from the disposal pits and ponds and the majority of site surface runoff exit the site, heading west, through the drainage ditches adjacent to the site access road (discussed in detail in Section 3.3).

5.1.3 Groundwater

The groundwater pathway is considered to be a potential route of contaminant migration. Although there are not positively identified contaminant trends in the groundwater, there were some compounds and/or elements which have been observed to be present at elevated levels at various locations. The elevated constituents were primarily metals (barium, chloride, chromium, lead, nickel, etc.) with the exception of a few detects of benzene and chloroform.

The largest potential impact on the integrity of the groundwater under the site will most likely result from potential leachate/infiltration resulting from the disposal pits, while lesser impacts could potentially occur from surficially contaminated soils such as those found in the former tank battery area.

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5.2 CONTAMINANT MIGRATION

5.2.1 Surface Water

There is evidence of several site related contaminants leaving the site through the surface water pathway along the site access road. As discussed in detail in Section 4.2.1, the contaminants are primarily inorganic elements such as barium, calcium, chloride and sodium. The analytical data indicates that both the surface water and the underlying sediment have been affected by contaminant migration.

In general, the barium and chloride concentrations in the site drainage ditch sediment are highest near the outfall/overflow from the saltwater pond and decrease as the ditch proceeds to the west toward Route 167 (Figures 2.2-1 and 2.2-2). The surface water concentrations of barium, calcium, chloride and sodium were also detected at significantly higher values in the drainage ditches on-site than they were in the off-site Route 167 ditch, immediately after the confluence of the site runoff.

Filtered surface water samples collected at the outfall/overflow of the saltwater pond into the drainage ditch, revealed that approximately one-half of the detected concentrations were provided by suspended solids. This indicates that the apparent contaminant migration produced from the discharging saltwater pond waters (and ultimately all three disposal pits because of their interconnection as discussed in Section 3.3) has occurred in two forms; as dissolved constituents and as suspended solids.

The potential contaminant migration resulting from the surface water drainage of the former tank farm is also most likely present in the dissolved and suspended solid states.

The suspended solids content of the contaminants in the draining/overflowing surface water provides an explanation to the decreasing barium and chloride concentrations in the sediment as the drainage ditch progresses toward Route 167. The suspended solids (and their accompanying levels of contamination) may drop out of solution into the underlying sediment as the drainage ditch widens and the velocity of the drainage water decreases, as it progresses further away from its origin. Dilution resulting from the influence of additional surface water and accompanying sediment, may also be a factor in the decrease of levels detected.

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5.2.2 Groundwater

At present, there appears to be no contaminant trends in the groundwater at the site, although some elevated inorganics were detected at individual locations. The greatest potential impact on the integrity of the groundwater under the site will most likely result from leachate/infiltration of surface water from the disposal pits and/or other impacted source areas such as the former tank farm.

5.2.2.1 Potential Migration of Disposal Pit Wastes and Contaminated Tank Soils

The contaminants detected in the disposal pit sludges (described in detail in Sections 4.3.3, 4.3.4 and 4.3.5) include various organic compounds and inorganic elements. The organic compounds detected include volatile organics [benzene, toluene, ethyl benzene and xylenes (BTEX) and chloroform], semivolatile organics (PAHs), various pesticides, a number of tentatively identified compounds (TICs), large values of total petroleum hydrocarbons (TPH) and low levels of dioxins and furans. The inorganic constituents included arsenic, barium, chloride, chromium and lead. The clay samples collected during the RI, from the clay material underlying the disposal pits, revealed that this underlying soil has been impacted by contaminants migrating downward from the sludge, however, the values detected were significantly lower than levels detected in the sludge.

There were various contaminants detected in the tank farm soils also. The levels detected, however, were generally quite a bit lower than what was detected in the disposal pits, therefore, the following discussion emphasizes the levels of contaminants found in the disposal pits. The organic compounds and inorganic constituents which were detected in the tank soils were found to be primarily restricted to the surface soils.

The subsurface fate of organic compounds is controlled by a number of physical and chemical processes. These processes include hydrolysis, sorption, cosalvation, ionization, biodegradation, volatilization and dissolution (U.S. EPA, 1989b). The degree to which each of these processes are affecting the migration of organic contaminants through the vadose zone and groundwater system is not known.

Very few of the sludge contaminants were detected in the groundwater samples. The only organic compound that was found consistently throughout the pits and was also detected in the groundwater was benzene. Benzene was detected in two well samples (MW-5 and MW-7) and was reported at levels below its MCL in both cases. These measured levels were not found adjacent to the pits, therefore the actual presence of the material in the wells and its source is suspect. If hydrocarbon contamination was occurring, it would be expected that the more soluble compounds (such as benzene) would leach from the contaminated material and enter the groundwater system. The wells located adjacent to the disposal pits did not indicate that this is occurring.

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The large reduction in the levels of contamination measured in the underlying clay compared to sludge concentrations also indicates that one or a combination of the previously mentioned processes are reducing the migration of contaminants from the pits.

The fate of inorganic constituents are also affected by a number of reactions in the subsurface, including dissolution, complexation reactions, adsorption, redox reactions and ion exchange (U.S. EPA, 1989b). The mobility of metals depends on the forms or "species" present in the subsurface. These forms could include: free ions, insoluble species, metal/ligand complexes, adsorbed species, species held on a surface by ion exchange and oxidation state differences. Because of the large surface area of the particulate matter within the subsurface, the adsorption of metals onto the surface of soil or clay particles is commonly the most important process governing metals transport.

Adsorption has been shown to be an important factor at the PAB site. Obvious differences in the concentrations of metals exist between the total and dissolved (filtered) groundwater samples. Many of the total metals samples contained clay and silt size sediment particles that are believed to have contributed significantly to the metals concentrations at several wells. Elevated dissolved phase metals (capable of passing a 0.45 micron filter) were also present.

Chromium and nickel were two of the most prevalent elevated constituents in the groundwater under the site. Unlike many of the other elements, including chromium, nickel remained at high concentrations when the samples were filtered. Other elevated constituents which appeared in one or more of the monitoring wells, such as aluminum, barium, chloride and lead, were also reduced in concentration when the samples were filtered.

5.2.2.2 Estimates of Contaminant Migration Rates in the Groundwater

Models predicting the transport of nonreactive contaminants (for example, chloride) in the groundwater environment are typically based on the advection-dispersion equation (NRC, 1984). Included in this model are terms for the average groundwater flow velocity and dispersion. The average linear flow velocity can be estimated by the following equation:

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$$V = \frac{KI}{n}$$

where:

- V = average linear velocity (ft/day)
- K = hydraulic conductivity (ft/day)
- I = hydraulic gradient (ft/ft)
- n = effective porosity (percent)

For the flow velocity calculation of groundwater under the site, an estimated hydraulic conductivity value of 57 ft/day (maximum value calculated from the slug tests) was used. The effective porosity was assumed to be 0.20. Based on these values and a measured hydraulic gradient of 0.0002 ft/ft across the site, an average linear flow velocity of 0.057 ft/day was calculated.

Dispersion in porous media refers to the spreading of a plume of contaminants as it flows through the subsurface and is caused by heterogeneities in the geologic materials. Dispersion alters the concentration profile in a groundwater plume so that the region, where the contaminants would be expected to occupy from advection alone, is expanded. Although dispersion would have a tendency to expand the plume, the mean rate of movement of the conservative contaminants would be expected to be nearly equal to the mean groundwater velocity (Walton, 1988).

An approximation of the distance (D) from the center of a chloride plume to its outer edge can be made by the following equation (assuming the hydraulic properties of the aquifer remain constant)

$$D = V \cdot T$$

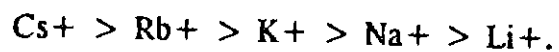
where:

- D = Distance downgradient from the source to leading edge of chloride plume (ft).
- V = Average linear groundwater velocity (ft/day).
- T = Time since chloride entered groundwater (days).

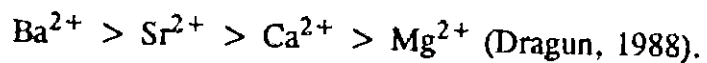
Assuming that the PAB Oil waste disposal operation began in late 1978 (~ 14 years ago), a maximum estimated travel distance of 291 ft, can be calculated for chloride. Although the presence of a chloride plume has not been confirmed by the analytical data, this issue was suspected by previous investigations (see Section 4.5.1.2).

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In the case of nonconservative contaminants, retardation of contaminant movement may occur as the result of chemical reactions, sorption to organic particles or biological reactions. For monovalent cations, the general order for adsorption to soils (the "Lyotropic series") is:



For divalent cations the order is generally:



From this information, barium groundwater contamination would be expected to travel at a slower velocity compared to groundwater contamination resulting from a conservative ion such as chloride.

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6.0 BASELINE RISK ASSESSMENT SUMMARY

A baseline risk assessment (BRA) was prepared (LSI, 1993a) to analyze the potential adverse health effects (both current and future) resulting from human exposure to hazardous substances in surface soil, sludge, sediment, groundwater and surface water at the PAB Oil and Chemical Services Superfund site. By definition, a BRA evaluates risk under the no-action alternative (that is, in the absence of any remedial actions to control or mitigate releases or exposures). The BRA for this site was prepared utilizing data from the Remedial Investigation and submitted to EPA as a "stand-alone" document. The methods used in the development of the risk assessment are based on general guidance provided by USEPA (Office of Emergency and Remedial Response. Risk Assessment Guidance for Superfund. Vol. I. Human Health Evaluation Manual (Part A), 1989) and in accordance with site-specific guidance provided by USEPA Region VI. In addition, an environmental risk assessment was conducted to evaluate risks to environmental species (LSI, 1993b). The majority of this section presents a summary of the results from the human health risk assessment. Subsection 6.6 provides a summary of the environmental assessment.

6.1 CHEMICALS OF POTENTIAL CONCERN

Analytical data from sludge, soil, groundwater, surface water and sediments were evaluated to identify chemicals of potential concern at this site. Any chemical detected in any sample was considered to be a possible chemical of concern. Chemicals were eliminated from consideration if they are essential nutrients and are nontoxic at the levels encountered on site or if they were infrequently detected. Seventy-five chemicals selected as contaminants of potential concern are listed in Table 6.1-A.

6.2 EXPOSURE SCENARIOS EVALUATED

Based on a review of site conditions including land use, contamination patterns and human activity patterns, the populations most likely to be exposed are:

- Current on-site trespassers.
- Current off-site residents (adults and children).
- Future on-site resident farmers (adults and children).

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TABLE 6.1-A CHEMICALS OF POTENTIAL CONCERN AT PAB OIL

Volatiles

Acetone
 Benzene
 Butanone, 2-
 Chloroform
 Dichloroethane, 1,1-
 Ethylbenzene
 Methylene chloride
 Tetrachloroethene
 Toluene
 Xylene (total)

Semivolatiles

Benzoic acid
 Dibenzofuran
 Dichlorobenzene, 1,2-
 Dimethylphenol, 2,4-
 Methylphenol, 2-
 Methylphenol, 4-
 Phenol
 Bis (2-ethylhexyl) phthalate
 Butylbenzylphthalate
 Di-n-butylphthalate
 Di-n-octylphthalate
 Diethylphthalate

PAHs

Acenaphthene
 Acenaphthylene
 Anthracene
 Benzo (a) anthracene
 Benzo (a) pyrene
 Benzo (b) fluoranthene
 Benzo (g,h,i) perylene
 Benzo (k) fluoranthene
 Chrysene
 Fluoranthene
 Fluorene
 Indeno (1,2,3-cd) pyrene
 Methylanthralene, 2-
 Naphthalene
 Phenanthrene
 Pyrene

Pesticides/PCBs

Aldrin
 Alpha-BHC
 Alpha chlordane
 Arochlor-1260
 Beta-BHC
 DDD, 4,4'-
 DDE, 4,4'-
 DDT, 4,4'-
 Delta-BHC
 Dieldrin
 Endosulfan I
 Endosulfan II
 Endosulfan sulfate
 Endrin
 Endrin aldehyde
 Endrin ketone
 Gamma chlordane
 Gamma-BHC
 Heptachlor
 Heptachlor epoxide
 Methoxychlor

Inorganics

Aluminum
 Antimony
 Arsenic
 Barium
 Beryllium
 Cadmium
 Chromium
 Cobalt
 Cyanide
 Lead
 Mercury
 Nickel
 Silver
 Thallium
 Vanadium

Dioxins/Furans

TCDD-equivalent

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The most important exposure pathways are judged to be:

- Ingestion of and dermal contact with contaminated surface soil, sludge and sediments.
- Ingestion of homegrown vegetables, beef and milk raised in contaminated soil or sludge.
- Ingestion of groundwater, along with dermal contact with water (while bathing) and inhalation exposure to VOCs released from groundwater to indoor air.
- Dermal exposure to surface water in pits, ponds, marshes and ditches.

The exposure scenarios quantified in this risk assessment are summarized in Table 6.2-A.

6.3 ESTIMATED HUMAN HEALTH RISKS

6.3.1 Cancer Risks

The risk of cancer from exposure to a chemical is described in terms of the probability that an individual exposed for his or her lifetime will develop cancer. Typically, cancer risks of $1\text{E-}06$ (one in a million) or lower are considered to be so small that they are of no practical concern. Higher cancer risk levels may be cause for concern, and the U.S. EPA typically requires site remediation if risks exceed $1\text{E-}04$. Estimated cancer risks from exposures to the chemicals of potential concern at PAB Oil are summarized in Table 6.3-A.

Cancer risk for current trespassers, mainly from exposure to sludge and surface water in the Northeast Pit and South Pit, is estimated to be about $2\text{E-}04$. The main contributors to this risk are the carcinogenic PAHs, PCBs, beryllium and pesticides.

Cancer risk to current off-site residents associated with exposure to sediment and surface water is about $1\text{E-}05$. This risk is predominantly due to beryllium in the surface water.

Excess cancer risk to hypothetical future on-site residents in the Pit area is estimated to be $9\text{E-}04$. This risk is contributed mainly by exposure to PAHs in soil, primarily via food chain intake ($3\text{E-}04$), and by arsenic and beryllium in the groundwater ($5\text{E-}04$). If the Northwest and Northeast Pits were excavated and the sludge spread on the land surface, the excess cancer risk to residents would be significantly higher ($2\text{E-}02$). This risk is attributable mainly to direct contact and food chain exposure to PCBs, PAHs and dioxins.

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TABLE 6.2-A
SUMMARY OF EXPOSURE SCENARIOS SELECTED FOR QUANTIFICATION

<u>Land Use</u>	<u>Exposed Population</u>	<u>Exposure Point</u>	<u>Exposure Media</u>	<u>Exposure Routes</u>
Current	Trespasser ^(a)	On-Site (Northwest Pit, Northeast Pit, South Pit, Salt Water Pond, Southeast Marsh, Northwest Pond/Ditch)	Sludge Sediment Surface Water	Oral/Dermal Oral/Dermal Dermal
Current	Resident	Off-Site Drainage Ditch, Residential Wells	Sediment Surface Water Groundwater	Oral/Dermal Dermal Oral/Dermal
Future	Resident	On-site ^(b) (Pit Area)	Soil Groundwater Garden Vegetables Beef Milk	Oral/Dermal Oral/Dermal/Inhal (VOCs) Oral Oral Oral
Future	Resident	On-site ^(c) (Pit Area)	Sludge Groundwater Garden Vegetables Beef Milk	Oral/Dermal Oral/Dermal/Inhal (VOCs) Oral Oral Oral

- (a) Scenarios in which a trespasser is exposed at various sources on-site may also apply to hypothetical future on-site residents.
 (b) Assumes current site conditions (i.e., sludge is located in pits).
 (c) Assumes pit sludge is excavated and spread on surrounding land.

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TABLE 6.3-A POPULATION TOTAL EXCESS CANCER RISKS

<u>Exposed Population</u>	<u>Exposure Location</u>	<u>Total Excess Cancer Risk</u>
Current On-Site Trespasser	Site-Wide Total	2E-04
Current Off-Site Resident	Drainage Ditch	1E-05
Future On-Site Residents	Pit Area (Current Conditions)	9E-04
	Pit Area (Sludge spread on ground)	2E-02

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These risks to residents are associated with exposures in and about the area of their home and yard. Assuming that older children and adults leave their yard area and are also exposed at pits, ponds, marshes and ditches located on site, the total cancer risk may be approximated by summing the risk to residents in their yard and home ($9E-04$) and the risk to trespassers ($2E-04$). If residents are exposed at pits, ponds, marshes and ditches more frequently than was assumed for trespassers (60 days per year), the excess risk would be proportionately higher.

6.3.2 Noncancer Risks

Evaluation of noncarcinogenic risk is accomplished by comparing a calculated intake with an acceptable intake for each chemical and for each pathway that contributes to a population's exposure. The ratio of the calculated intake versus the acceptable intake is termed the Hazard Index (HI). Hazard Indices calculated for all the exposure scenarios quantified at PAB Oil are summarized in Table 6.3-B.

Noncancer risks do not appear to be of concern for current off-site residents. Current on-site trespassers may have increased risk of noncancer effects due mainly to dermal exposure to pesticides in the South Pit. For hypothetical future on-site residents, hazard index values are estimated to be $1E+01$ for adults and $2E+01$ for children under current site conditions. This risk is due primarily to arsenic, antimony, chromium, nickel and vanadium in the drinking water, with lower but sometimes significant contribution from barium in soil. If the sludge from the Pits was spread on the land surface, noncancer risks to adults and children would be $2E+01$ and $3E+01$, respectively. This additional risk is associated mainly with organics (di-n-octylphthalate, acetone, PAHs) which tend to accumulate in the food chain, with a significant contribution from barium in sludge as well.

The likely effect of exposures to lead from site contamination were estimated using EPA's Uptake/Biokinetic model. Blood lead levels are predicted to average $1.8 \mu\text{g/dL}$ for children exposed at the pit area, with very low probability that any levels would exceed $10 \mu\text{g/dL}$. If sludge were excavated from the Northwest and Northeast Pits, the blood lead levels of exposed children would average $3.5 \mu\text{g/dL}$, with only a 0.1 % chance that an individual would exceed $10 \mu\text{g/dL}$. This indicates that lead exposure from either surface soil or sludge is not of major concern.

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TABLE 6.3-B POPULATION TOTAL HAZARD INDEX VALUES

<u>Exposed Population</u>	<u>Exposure Location</u>	<u>Screening Level HI Value</u>
Current On-Site Trespasser	Site-Wide Total	5E+00
Current Off-Site Resident Adults	Drainage Ditch	1E-02
Current Off-Site Resident Children	Drainage Ditch	1E-01
Future On-Site Resident Adults	Pit Area (Current Conditions)	1E+01
	Pit Area (Sludge spread on ground)	2E+01
Future On-Site Resident Children	Pit Area (Current Conditions)	2E+01
	Pit Area (Sludge spread on ground)	3E+01

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6.4 LIKELY SOURCES OF CHEMICALS OF CHIEF CONCERN

Table 6.4-A summarizes the chemicals that were found to be the chief contributors to cancer and noncancer risks at the site. The following section presents a brief evaluation of the likely source of each of these contaminants.

6.4.1 PAHs

Although some PAHs occur naturally and others arise from area sources such as automobile exhaust or incinerators, there is little reason to think that the PAHs detected on site are not waste-related. First, PAHs are known constituents of petroleum, especially when heated, and petroleum oils were an important component of the wastes disposed of on site. Second, the average of PAHs detected in sludge is 37 times higher than levels detected in soil. However, because of the oily nature of the sludges and some of the soil samples, considerable analytical difficulty was encountered in attempting to measure PAH levels. Thus, while PAHs are judged to be authentic contaminants of concern, the level of risk posed by the PAHs is difficult to quantify accurately.

6.4.2 Dioxins

Polychlorinated dibenzodioxins and dibenzofurans typically are also generated during the heating or burning of organic matter. The levels detected on site are all relatively low, but average levels in sludges (1 ppb) are substantially higher than in surrounding soils (0.02 ppb). This indicates that the sludge is the most likely source of the dioxins.

6.4.3 Inorganics

A number of inorganic chemicals contribute to cancer and noncancer risks, both in groundwater and in soil and sludge. Based on a comparison to background, it is clear that levels of barium are significantly elevated in soil, and this is consistent with the high barium content of some of the wastes. With respect to other inorganics (arsenic, beryllium), on-site levels in soil appear to be similar to background levels, although some may be somewhat elevated. This suggests that most of the risks from these chemicals are natural in origin, with perhaps some contribution from on-site wastes. Comparisons of on-site and available background groundwater concentrations indicate that chromium, nickel and possibly vanadium are elevated on-site, but data are not sufficient to establish whether barium is elevated or not.

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TABLE 6.4-A SUMMARY OF CHEMICALS OF PRIMARY CONCERN

Health Effect Category	Chemicals of Primary Concern		
	Soil	Sludge	Groundwater
Cancer	PAHs Dioxins Arsenic	PAHs Dioxins Arsenic PCBs Pesticides	Arsenic Beryllium
Noncancer	Barium Arsenic	PAHs Acetone Di-n-octylphthalate Barium	Antimony Arsenic Barium Chromium Nickel Vanadium

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6.4.4 Phthalates, Acetone

Di-n-octylphthalate and acetone in sludge were found to contribute to noncancer risks via food chain exposures. These chemicals are common laboratory contaminants, and it seems possible that much of the risk attributed to these chemicals is due to laboratory contamination rather than to authentic site contamination. However, this is not certain, since some on-site samples contained relatively high levels of acetone compared to levels detected in the blanks and di-n-octylphthalate was not detected in blanks associated with sludge analysis.

6.5 UNCERTAINTIES

There are a number of stages in the risk assessment process where precise evaluations are not possible. These include uncertainties regarding the true concentrations of chemicals in environmental media, the amount of contaminants taken in by humans and the likely health consequences of the resulting exposure. In particular, the following items are sources of uncertainty in this risk assessment.

6.5.1 Likely to Underestimate Risk

- Lack of toxicity data for numerous chemicals (e.g., TICs).
- Inability to quantify some pathways (e.g., dermal contact with PAHs, dermal contact with metals in soil, uptake of metals into the food chain).

6.5.2 Likely to Overestimate Risk

- Use of conservative human exposure assumptions.
- Use of conservative toxicity values.

6.5.3 Might Either Overestimate or Underestimate Risk

- Evaluation of nondetects using one-half the detection limit (this is especially important for chemicals with a high frequency of nondetects, such as PAHs, beryllium and pesticides).
- Use of simple models to predict uptake of organics into the food chain.

As noted, some of these limitations may lead to an underestimate of risk, some are more likely to overestimate than underestimate risk and some introduce uncertainty that may either overestimate or underestimate risk. Consequently, the quantitative risk estimates derived for this site should be considered approximate, with a significant range of uncertainty.

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6.6 ENVIRONMENTAL ASSESSMENT

A screening-level environmental assessment was performed for the PAB Oil site. Local species of wildlife of minor recreational importance and migratory waterfowl are the only ecological resources of potential significance associated with this site. No rare, threatened or endangered species are associated with the site and nearby areas. No jurisdictional wetlands are present on the site or in nearby areas. Nearby surface water bodies (ditches and canals) are semipermanent and are unlikely to support regionally significant aquatic communities.

Areas, contaminants and potentially exposed populations of concern are as follows:

- Aquatic life exposed to iron in surface water in the salt water pond and southeast marsh area.
- Aquatic life exposed to chromium, lead and manganese in sediment in the salt water pond and lead and mercury in the off-site ditch.
- Rabbits ingesting vegetation contaminated with barium from soil in the southeast marsh area.

Higher trophic level organisms that may feed on rabbits in the southeast marsh area are unlikely to experience adverse effects from exposure to barium. Migratory waterfowl are unlikely to be exposed to the relatively low toxicity of chemicals present in the two larger water bodies on site (salt water pond and northwest pond) for sufficient time to experience a dose potentially associated with adverse effects.

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